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(РОСАВИАЦИЯ)

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Е.В. Черняева, Е.Н. Николаева

ИНОСТРАННЫЙ ЯЗЫК ПО ПРОФИЛЮ ПОДГОТОВКИ «АНГЛИЙСКИЙ ЯЗЫК»

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по профилю «Техническая эксплуатация
летательных аппаратов и двигателей»

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Московский государственный технический университет ГА
125993, Москва, Кронштадтский бульвар, д. 20

Издательский дом Академии имени Н. Е. Жуковского
125167, Москва, 8-го Марта 4-я ул., д. 6А
Тел.: (495) 973-45-68
E-mail: zakaz@itsbook.ru

Оглавление

Unit 1
ADVANCED GAS TURBINES HEALTH MONITORING SYSTEMS

Vocabulary:

1. Axial compressor – осевой компрессор
2. Combustor - камера сгорания
3. To extract - извлекать
4. Expanding gases – расширяющиеся газы
5. Shaft - вал
6. Application - применение
7. Advantages - преимущества
8. Reliability - надежность
9. Availability – доступность
10. Low emissions – низкие выбросы
11. Carbon oxide – оксид углерода
12. Nitrogen oxide – оксид азота
13. Flexibility - гибкость
14. Exhaust gases – выходящие газы
15. Density - плотность
16. Surge – резкий рост
17. Pursuit - стремление
18. Compression ratio – коэффициент сжатия
19. Ceramic coating – керамическое покрытие
20. Superalloy - суперсплав

Read and translate the text.

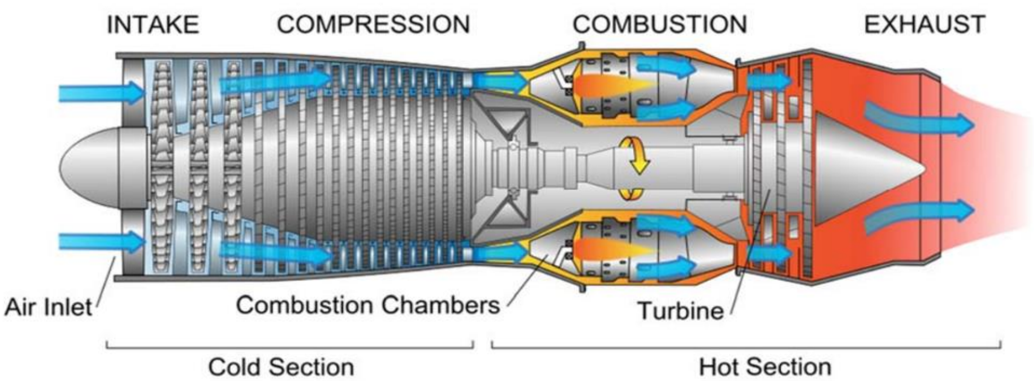
INTRODUCTION

Gas turbines operate on the Brayton's thermodynamic cycle where air is compressed by an axial or a centrifugal compressor and fuel is added which is then burnt in the combustor. The power turbine extracts work from the expanding gases propelling both the compressor and the shaft. Power turbine work is used to drive compressor, generator, pump, etc. The main components of a gas turbine are: compressor, combustor and power turbine.

Gas turbines are widely used in industrial applications due to many advantages over other technologies such as: high reliability and availability, wide power range, clean energy production, low carbon oxides and nitrogen oxides emissions, fuel flexibility, exhaust gases can be reused for other processes, dense modular design, high power density, short construction time, low cost of generated power and short start-stop cycle time.

These advantages over other technologies have led to a surge in new installations over the last couple of decades. There has been much progress made in gas turbine technologies. The pursuit of higher efficiency is driven by a higher compression ratio and increased turbine inlet temperature: ceramic coatings, superalloys, single crystal technology. Higher efficiency should go hand in hand with increased reliability and availability.

The turbojet engine shown below has air inlet conditions of 0.3 bar and 250 K at a



velocity of 265 m/s. The air decelerates through the intake section until its velocity is essentially zero.

The compressor has a pressure ratio (p_{outlet}/p_{inlet}) = 20 and an exit temperature of 600 K.

The combustor exit temperature is 1750 K. All the turbine haft power goes to driving the compressor.

Finally, the nozzle exit pressure and temperature are 0.3 bar and 850 K, respectively.

Exercise 1. Answer the following questions:

1. What is gas turbines operation principle?
2. What is the turbine power used for?
3. What are the main components of a gas turbine?
4. Where and why are gas turbines widely used?
5. What has led to a surge in new installations over the last couple of decades?
6. What is the reason for a pursuit of higher efficiency?

Exercise 2. Read and translate the following word combinations:

Thermodynamic cycle, centrifugal compressor, power turbine extracts, expanding gases, industrial applications, due to many advantages, high reliability and availability, wide power range, clean energy production, fuel flexibility, can be reused for other processes, dense modular design, high power density, low cost of generated power, lead to a surge in new installations, a couple of decades, pursuit of higher efficiency, a higher compression ratio, increased inlet temperature, single crystal technology, higher efficiency, increased reliability and availability.

Exercise 3. Find in the text English equivalents to the following expressions:

Газовые турбины; термодинамический цикл; воздух сжимается; топливо добавляется и сжигается; камера сгорания; турбина извлекает энергию; приводить в движение как компрессор, так и вал; мощность силовой турбины; основные компоненты газовой турбины; газовые турбины широко используются; благодаря многим преимуществам; высокая надежность и доступность; широкий диапазон мощности; экологически чистое производство энергии; низкие выбросы оксидов углерода и оксидов азота; топливная гибкость; выходящие газы могут быть повторно использованы; плотная модульная конструкция; высокая мощность; короткое время производства; низкая стоимость вырабатываемой электроэнергии; короткое время цикла пуска-остановки; прогресс в области газотурбинных технологий; стремление к более высокому КПД; более высокий коэффициент сжатия; повышенная температура на входе турбины; более высокая эффективность; повышенная надежность и доступность.

Exercise 4. Make up all possible types of questions:

1. Gas turbines operate on the Brayton's thermodynamic cycle.
2. These advantages over other technologies have led to a surge in new installations over the last couple of decades.
3. Gas turbines are widely used in industrial applications.
4. Exhaust gases can be reused for other processes.
5. Higher efficiency should go hand in hand with increased reliability and availability.

Exercise 5. Translate the following sentences into English:

1. Газовые турбины широко используются в промышленности.
2. . Основными компонентами газовой турбины являются компрессор, камера сгорания и силовая турбина.
3. Воздух сжимается осевым или центробежным компрессором.
4. Выходящие газы могут быть повторно использованы для других процессов.
5. Значительный прогресс был достигнут в области газотурбинных технологий.
6. Газовые турбины работают по термодинамическому циклу Брайтона.
7. Турбина извлекает энергию из расширяющихся газов.

Exercise 6. Find in the text the sentences with the verbs in the Passive voice, explain their usage.

Exercise 7. Find in the text the nouns with the suffixes –or, -tion and say what verbs they are derived from.

Exercise 8. Retell the text.

Unit 2.

Read and translate the text:

ADVANCED GAS TURBINES HEALTH MONITORING ALGORITHM

The term Advanced Gas Turbine Health Monitoring System (AGTHMS) is viewed as a system that monitors a machine and detects faults and predicts the performance degradation. Data mining is followed by performance evaluation and abnormal operation detection in search of pre-failure symptoms. To perform the above functions effectively, the following requirements should be met:

- system should be automated as much as possible in monitoring, system analysis and supporting decision making;
- robust against noisy signal and faulty information;
- wide range of detectable faults and adjustability to newly discovered faults which may not be initially reported;
- use existing instruments or as few new ones as possible;
- flexible, modular and open architecture allowing an easy adaptation to operator needs;

user-friendliness so that unskilled personnel can use it with minimum training.

Additionally, the following elements must be implemented:

- acquisition of measurement data;
- evaluation of data to discard unreliable and faulty sensor readings;
- data processing to derive useful diagnostics information;
- management of historic data to maintain records of valuable information.

AGTHMS should monitor various parameters simultaneously such as Gas Path Analysis (GPA), vibration level, oil debris detection and engine actuators. A combination of different classifiers can be employed with oil debris low and high lube oil differential temperature (difference between lube oil supply and drain bearing temperature) will execute a shutdown command confirming the abnormal bearing operation. Individual readings could give a false indication due to sensor or controller malfunction, however a combination of more than one readings can improve the decision-making algorithm. Merging information from different instruments will reduce the number of false trip alarms caused by a sensor malfunction. Moreover, equipment abnormalities can be detected before they develop into failure.

Gas turbines often utilize redundant sensors for monitoring critical parameters. However, this increases overall package cost and adds complexity to both electrical and mechanical systems. With AGTHMS it can be possible to monitor engine sensor health status indirectly by taking advantage of other readings. The simple example can be found in relationship between shaft rotational speed and the first harmonic of the spectrum analysis from a proximity probe. When both the engine bearing and the sensor are healthy, readings should correlate but in case they do not a possible malfunction could be present and an alarm or shutdown should be initiated.

Analyzing the vibration spectrum and comparing them with readings from a different sensor, such as a speed probe, can bring the following benefits:

- Sensor cross-check – increased system integrity level without the need for redundant sensors;
- Gas turbine alarm/shutdown counteraction is based on several rather than on a single reading.

Vocabulary:

1. To detect - обнаруживать
2. Fault - неисправность
3. Faulty - неисправный
4. Performance - производительность
5. Evaluation - оценка
6. Requirement - требование
7. Robust - устойчивый, крепкий
8. Range - диапазон
9. Adjustability - приспособляемость
10. Instruments - приборы
11. Flexible - гибкий
12. To implement - осуществлять
13. Acquisition - приобретение
14. To derive - извлекать
15. Simultaneously - одновременно
16. Debris – посторонние предметы
17. Lube – смазка, лубрикант
18. Shutdown - выключение
19. Malfunction – неисправность, несрабатывание
20. To utilize - использовать
21. Redundant - резервный
22. Proximity probe – бесконтактный датчик
23. Benefits - преимущества
24. Cross-check – перекрестная проверка
25. Counteraction - противодействие
26. Readings – показания

Exercise 1. Answer the following questions:

1. What does AGTHMS stand for?
2. What is the function of AGTHM system?
3. What requirements should be met to perform the functions of the system effectively?
4. What additional elements must be implemented?
5. What parameters should AGTHM system monitor simultaneously?
6. What can occur due to sensor or controller malfunction?
7. What can improve the decision-making algorithm?
8. What will reduce the number of false trip alarms?
9. Why do gas turbines utilize redundant sensors?
10. What are the disadvantages of the redundant sensors?
11. What should be initiated in case of engine bearing and sensor malfunction?
12. What are the benefits of comparing the vibration spectrum with speed probe readings?

Exercise 2. Read and translate the following word combinations:

Advanced Gas Turbine Health Monitoring System, to detect faults, performance degradation, performance evaluation, abnormal operation detection, pre-failure symptoms, to support decision- making, faulty information, newly discovered faults, existing instruments, to allow an easy adaptation, unskilled personnel, to discard unreliable readings, to derive useful information, oil debris detection, to execute a shutdown command, abnormal bearing operation, individual readings, a false indication, merging information, to reduce the number of false trip alarms, equipment abnormalities, to develop into failure.

Exercise 3. Find in the text English equivalents to the following expressions:

Усовершенствованная система мониторинга технического состояния газовой турбины; обнаруживать неисправности; прогнозировать снижение производительности; оценка производительности; обнаружение аномалий в работе; выполнять требования; поддержка принятия решений; использовать существующие приборы; адаптироваться к потребностям оператора; оценка данных; устранение ошибочных показаний датчиков; обработка данных; ведение учета ценной информации; уровень вибрации; обнаруживать примеси в масле; аномальная работа подшипника; ложная индикация; неисправность датчика; улучшить алгоритм принятия решений; уменьшить количество ложных срабатываний; резервные датчики; усложнять как электрические, так и механические системы; косвенно контролировать состояние датчиков двигателя; инициировать сигнализацию или остановку; перекрестная проверка датчиков; противодействие сигналу тревоги.

Exercise 4. Make up all possible types of questions:

1. Gas turbines often utilize redundant sensors for monitoring critical parameters.
2. Merging information from different instruments will reduce the number of false trip alarms.
3. Equipment abnormalities can be detected before they develop into failure.
4. This increases package cost and adds complexity to both electrical and mechanical systems.
5. Gas turbine alarm/shutdown counteraction is based on several readings.

Exercise 5. Translate the following sentences into English:

1. Отдельные показания могут давать ложную индикацию из-за неисправности датчика.
2. В газовых турбинах часто используются резервные датчики для мониторинга критических параметров.
3. Объединение информации от разных приборов уменьшит количество ложных срабатываний, вызванных неисправностью датчика.
4. Система мониторинга должна одновременно контролировать различные параметры, обнаруживать примеси в масле и контролировать работу приводов двигателя.
5. Система должна быть максимально автоматизирована в области мониторинга, системного анализа и поддержки принятия решений.
6. Система должна быть устойчива к шумным сигналам и ошибочной информации.
7. Система должна использовать существующие приборы или как можно меньше новых.

Exercise 6. Complete the following table using suitable forms:

Verb	Noun
to perform	
	evaluation
to implement	
	requirement
	decision
to correlate	
	measurement
to utilize	
	combination
to compare	
to develop	

Exercise 7. Read, translate and retell the following text:

In the aviation industry, effective aircraft maintenance management is crucial for staying compliant and ensuring uptime. Streamlining maintenance and operations tasks through fleet management software gives your team a comprehensive look at the health of your assets both on the ground and in the sky. An effective aircraft maintenance management process requires collaboration across the entire team. Troubleshooting issues can be difficult when you are using paper-based logs and reports. With aircraft maintenance management software, you and your crew can track, maintain and analyze a complete system of record for your fleet from anywhere.

Unit 3.

Read and translate the text:

PROBLEM DEFINITION

A typical arrangement of the main components in the engine health monitoring system usually takes into account monitoring such parameters as temperatures, pressures, flow parameters, vibration level and speed. These are passed to a digital controller which contains a set of pre-defined rules (i.e. If value x is less than y the engine is *OK*, on the contrary an alarm signal is sent or shutdown engine safely). Standard arrangement is sufficient for majority of engine operation. The fast digital controller can act upon rapid changing conditions allowing safe and efficient operation of the engine. The main advantages of this condition-based control are: an implementation simplicity and a straightforward modification procedure when necessary. However, it often lacks a prognosis value and a comprehensive diagnostics functionality as the majority of analyzed data based on the pre-defined “IF-THEN” rules.

More advanced diagnostics and prognostics require a new approach. Enhanced arrangement provides additional signal processing solely dedicated to engine health and performance monitoring. The key elements in this system are: Observer, Signal Decomposition & Conditioning and Condition Assessment. Signal Decomposition & Conditioning block can allow advanced processing of signals registered by vibration and displacement sensors. This pre-processing of raw data allows for an extraction of interesting features for a user in such a way that an incipient fault can be detected and acted upon before it develops into a failure.

The key feature of Enhanced Arrangement is to allow the self-condition assessment and do it effectively. Health classification algorithm, imbedded in Condition Assessment block, requires a residual between the measured and the predicted outputs. This forecast can be archived by Observer, which consists of regression methods accurately predicting expected engine outputs for a given operating point (engine speed, load, temperature, etc.). Classification methods can employ expert knowledge to correctly label symptoms to a potential problem and make decision: whether to or not to continue engine operation, adjust setpoints, inform operator or shut down the engine.

Vocabulary:

1. Arrangement - расположение
2. To contain - содержать
3. Value - значение
4. On the contrary - наоборот
5. Sufficient - достаточный
6. Majority - большинство
7. Simplicity - простота
8. Straightforward - незамысловатый
9. To lack – испытывать недостаток
10. Comprehensive - всесторонний
11. Advanced - продвинутый
12. Enhanced - усовершенствованный
13. Additional - дополнительный
14. Assessment - оценка
15. Displacement - смещение
16. Raw data – исходные данные
17. Extraction - извлечение
18. Incipient fault – зарождающийся сбой
19. Feature – черта, свойство
20. Imbedded – встроенный, вложенный
21. Residual - остаточный
22. Forecast - прогноз
23. To consist of – состоять из
24. Output - выход
25. Setpoint – заданное значение

Exercise 1. Answer the following questions:

1. What parameters are taken into account for the engine health monitoring system?
2. What does a digital controller contain?
3. Which arrangement is sufficient for majority of engine operation?
4. What are the advantages and disadvantages of the condition-based control?
5. What does enhanced arrangement provide?
6. What are the key elements of the new system?
7. Why is pre-processing of raw data conducted?
8. What is the key feature of the enhanced arrangement?
9. What does health classification algorithm require?
10. What can classification methods employ?

Exercise 2. Read and translate the following word combinations:

Main components, to take into account, a set of pre-defined rules, majority of engine operation, rapid changing conditions, safe and efficient operation, condition-based control, comprehensive diagnostics functionality, to require a new approach, to provide additional signal processing, key elements, condition assessment, advanced processing of signals, a displacement sensor, raw data, to extract interesting features, an incipient fault, to develop into a failure, to be imbedded in Condition Assessment block, to archive the forecast, to employ expert knowledge, to predict accurately, to adjust, setpoints.

Exercise 3. Find in the text English equivalents to the following expressions:

Более продвинутая диагностика; новый подход; усовершенствованная компоновка; обеспечивать дополнительную обработку сигналов; ключевая особенность; обеспечить расширенную обработку сигналов; датчик смещения; исходные данные; извлечь интересные предпосылки; обнаружить зарождающийся сбой; использовать экспертные знания; отключить двигатель; типичное расположение; техническое состояние двигателя; учитывать параметры; содержать набор правил; быстрый цифровой контроллер; обеспечивать безопасную и эффективную работу двигателя; основные преимущества; простота реализации; большинство данных.

Exercise 4. Make up all possible types of questions:

1. More advanced diagnostics and prognostics require a new approach.
2. If an engine failure occurs while at cruise altitude, it may be necessary to descend.
3. The flaps are normally not used for increasing the descent rate.
4. Major repairs and overhauls are done by technicians and engineers in the hangar.
5. The fast digital controller can provide safe and efficient operation of the engine.

Exercise 5. Translate the following sentences into English:

1. Быстрый цифровой контроллер может действовать в быстро меняющихся условиях, обеспечивая безопасную и эффективную работу двигателя.
2. Основными преимуществами такого управления являются: простота реализации и простая процедура модификации при необходимости.
3. Более продвинутая диагностика и прогнозирование требуют нового подхода.
4. Усовершенствованная компоновка обеспечивает дополнительную обработку сигналов, предназначенную для мониторинга технического состояния и производительности двигателя.
5. Блок разложения и мониторинга сигналов может обеспечить

расширенную обработку сигналов, регистрируемых датчиками вибрации и смещения.

6. Ключевая особенность усовершенствованной системы состоит в том, что она позволяет проводить самоконтроль системы и делать это эффективно.

7. Методы классификации могут использовать экспертные знания для правильной маркировки симптомов потенциальной проблемы и принятия решения.

Exercise 6. Find in the text the sentences with the verbs in the Passive Voice, explain their usage.

Exercise 7. Form nouns from the verbs:

To equip, to arrange, to provide, to know, to act, to move, to exist, to locate, to add, to continue, to occur, to determine, to vibrate, to perform, to allow, to displace, to extract, to detect, to develop, to assess, to predict, to expect, to decide, to adjust.

Unit 4.

Read and translate the text:

Part 1.

OPERATION ADJUSTMENT

The operation of a typical industrial gas turbine will be governed by a set of "IF-THEN" rules and tunable constants. These will vary engine to engine as no customer site is identical and the manufacturing tolerance of gas turbines require a number of specific settings to be tailored to individual units. These can include inlet guide vane or bleed valve range, fuel starting schedule, fuel pressure at burner, engine shaft speed or pilot to main ratio for a low NOx emission engine and many more. A control system for a gas turbine should include parameters correction for a variation of an inlet temperature or a barometric pressure. This allows an on-line adjustment to the engine operation. However, in "**Standard Arrangement**", there are limitations in the self-adjusting capability as the control system uses "IF-THEN" rules. The self-adjusting ability of "**Enhanced Arrangement**" can be significantly increased. For example, a customer has received a different type of diesel fuel and now his engine is struggling to start on his liquid. Furthermore, the situation takes place in a remote location and the gas turbine manufacturing expert cannot mobilize himself on very short notice. The engine starts on liquid but fails to reach the minimum temperature in a defined time frame. An expert would probably adjust fuel command schedule for more aggressive behaviour. However, the personnel on-site are not qualified to carry out such modifications. AGTHMS could perform the system auto-diagnostics. In the first stage, Condition Assessment block receives "Engine Failed to Reach Temperature- Shutdown" alarm.

The algorithm performs a basic condition check on the actuators to eliminate their malfunction. In the next step of the algorithm, the occurrence of a certain number of failed start attempts is required before classifier can be triggered. In this example, two main causes are rectified with a probability of 72% and 28% respectively. The algorithm takes a decision to change fuel ramp and another start is initiated. This time engine exceeds the maximum temperature setpoint during start-up. The fuel ramp is reduced and the engine starts successfully.

Part 2.

FAULT CLASSIFIFCATION

Condition Assessment block is expected to accurately distinguish abnormal, leading to faults symptoms, from the false ones. A selected classifier will usually have a trade-off between a high recall or a precision.

A high recall will lead to more false alarm (lower precision) detections, making the system more sensitive to unusual operating conditions. It will be expected from this classifier to detect the majority of possible faults at expense of spurious faults. On the other hand, a high precision classifier will be less sensitive to abnormal (lower recall) states but less prompt to a false failure detection. Depending on the fault scenario the high precision classifier can be selected to make instantaneous counteraction such as engine shutdowns as it is going to be more robust to noise than high recall. In such cases, the high recall classifier can be effective in detecting symptoms, otherwise it would be missed by the precision focused classifier, therefore the output from it should be analyzed further by another algorithm or a system operator/an expert. Symptoms classified with high recall could be used with “Combined decision making” algorithm where more than one cause is required for a counteraction.

Part 1 Vocabulary:

1. To govern – руководить, регулировать
2. Tunable - настраиваемый
3. To vary - меняться
4. Manufacturing tolerance – производственный допуск
5. To be tailored – быть подогнанным, адаптированным
6. Inlet guide vane – входной направляющий аппарат
7. Bleed valve – выпускной клапан
8. A customer – клиент, заказчик
9. A burner - форсунка
10. Engine shaft speed – скорость вращения вала двигателя
11. Self-adjusting capability – возможность саморегулирования
12. Remote location – удаленное местоположение
13. To define - определять
14. Time frame – временной промежуток
15. To carry out - проводить

16. To eliminate - устранять
17. Malfunction – неисправность, несрабатывание
18. Occurrence - событие
19. An attempt - попытка
20. To trigger - срабатывать
21. To rectify - исправлять
22. Probability - вероятность
23. To exceed – превышать

Part 2 Vocabulary:

1. High recall – высокая степень запоминания
2. Accurately - точно
3. To distinguish - различать
4. A trade-off - компромисс
5. Sensitive - чувствительный
6. At expense of – за счет чего-либо
7. Spurious faults – ложные неисправности
8. High precision – высокая точность
9. Instantaneous counteraction – мгновенное противодействие
10. Robust - устойчивый
11. A cause – причина

Exercise 1. Answer the following questions:

Part 1.

1. How will the operation of a typical industrial gas turbine be governed?
2. What does manufacturing tolerance of gas turbines require?
3. What can specific settings include?
4. . Why should a control system for a gas turbine include parameters correction?
5. What limitations are there in Standard Arrangement?
6. How to increase the self-adjusting ability of enhanced arrangement? Give an example from the text.
7. What are the stages of auto-diagnostics of the advanced gas turbine health monitoring system?

Part 2.

1. What will a high recall lead to?
2. How can you detect the majority of possible faults?
3. How is a high precision classifier selected?
4. What counteraction occurs depending on the fault scenario?

Exercise 2. Read and translate the following word combinations:

Part 1:

a set of rules, tunable constants, manufacturing tolerance, require a number of specific settings, to be tailored to individual units, inlet guide vane, bleed valve range, fuel starting schedule, fuel pressure at burner, engine shaft speed, to include parameters correction, a variation of an inlet temperature, an on-line adjustment, self-adjusting capability, to be significantly increased, liquid, a remote location, gas turbine manufacturing, on short notice, a defined time frame, fuel command schedule, more aggressive behavior, perform auto-diagnostics, to perform a basic condition check, to eliminate malfunction, the occurrence of attempts, , two main causes are rectified, to exceed the maximum temperature.

Part 2:

to distinguish abnormal symptoms from the false ones, evaluation classifiers, to make the system more sensitive to smth, unusual operating conditions, to detect the majority of possible faults, at expense of spurious faults, false failure detection, to make instantaneous counteraction, engine shutdown, to be more robust to noise, combined decision making, to be required for a counteraction.

Exercise 3. Find in the text English equivalents to the following expressions:

эксплуатация промышленной газовой турбины, настраиваемые константы, варьироваться от двигателя к двигателю, площадка заказчика, производственные допуски, требовать ряд специфических настроек, быть адаптированным к отдельным агрегатам, диапазон работы входных направляющих аппаратов, выпускной клапан, график добавления топлива, давление топлива в форсунке, скорость вращения вала двигателя, коррекция параметров, регулировка в режиме реального времени, ограничения в возможности саморегулирования, способность к самонастройке, удаленное местонахождения, специалист по производству газовых турбин, в срочном порядке, определенный промежуток времени, график управления подачей топлива, устранить неисправность, определенное количество неудачных попыток запуска, приводить к появлению симптомов неисправности, иметь компромисс, ложное срабатывание, более низкая точность, повышать чувствительность системы, необычные условия эксплуатации, обнаружить большинство возможных неисправностей за счет ложных срабатываний, в зависимости от сценария неисправности, мгновенное противодействие, отключение двигателя, быть более устойчивым к шуму, классифицировать с высокой степенью запоминания, комбинированное принятие решений.

Exercise 4. Make up all possible types of questions:

1. The operation of a typical industrial gas turbine will be governed by a set of rules.
2. The manufacturing tolerance of gas turbines requires a number of

specific settings.

3. There are limitations in the self-adjusting capability.

4. The self-adjusting ability of Enhanced Arrangement can be significantly increased.

5. A control system for a gas turbine should include parameters correction.

Exercise 5. Translate the following sentences into English:

1. Эксплуатация типовой промышленной газовой турбины будет регулироваться набором правил и настраиваемых констант.

2. Они будут варьироваться от двигателя к двигателю.

3. Производственные допуски на газовые турбины требуют ряда специфических настроек.

4. Система управления газовой турбиной должна включать коррекцию параметров для изменения температуры на входе.

5. Однако, в стандартной компоновке есть ограничения в возможности саморегулирования.

6. Алгоритм выполняет проверку основного состояния исполнительных механизмов для устранения неисправности.

7. С другой стороны, высокоточный классификатор будет менее чувствителен к аномальным состояниям.

Exercise 6. Complete the following table using suitable forms:

Noun	Adjective	Verb
	tunable	
		prevent
precision		
		vary
	specific	
correction		…
		improve
failure		
		perform
	safe	
collection		
	determined	

Exercise 7. Choose the correct negative prefix:

correct normal to continue active usual	to fix to lock stable balance to mobilize	**in-** **im-** **un-** **dis-** **ab-**

Exercise 8. Read, translate and retell the following text:

Track and Schedule Aircraft Maintenance in a Centralized Location

When it comes to preventative maintenance (PM), the aviation industry needs to be at the top of its game. In addition to routine servicing, a commercial aircraft must be serviced after a certain number of flight hours in order to remain compliant with Federal Aviation Administration (FAA) and International Civil Aviation Organization (ICAO) standards.

Though maintenance processes are regulated, many aircraft fleets are not running as efficiently as they could be. Communication bottlenecks are caused when information can't be delivered quickly, which can result in aircraft downtime.

Leveraging aircraft maintenance management software allows your crew to seamlessly communicate so you can be proactive in solving maintenance issues.

Creating routine service schedules for your aircraft keeps your fleet organized and airworthy. With a PM scheduling tool, you can stay on top of regular servicing by setting reminders and due soon thresholds to help you maximize uptime.

When your aircraft does require maintenance, you don't want paperwork and spreadsheets slowing you down.

Generating work orders through your aircraft maintenance software allows your crew to get to work immediately. With detailed line items, you can efficiently track service work from start to finish and ensure your assets and equipment are primed for use.

Aside from scheduling and performing aircraft maintenance, it is important to be able to track data and run reports. Utilizing data and reports ensures you are efficiently allocating your resources.

Aircraft maintenance software allows you to generate customizable reports, track maintenance, view operational costs and gain insight into the overall health of your assets.

Unit 5.

Read and translate the text:

PROGNOSTICS AND DIAGNOSTICS

The two main functions of the advanced gas turbine health monitoring system are the **diagnostics**, which can be referred to as a function that detects present and past abnormalities, and the **prognostics**, which allows an estimation of the engine wear & tear and a prediction of faults.

Prognostics

The capability to predict the health of a machine component over time is at the foundation of Condition Based Maintenance. It relies on the current health assessment and uses this information to plot the degradation curve of a component allowing for time to failure prediction. The prognostic methods can be classified as data-driven and model-based.

Data-driven prognostics

This approach relies on the assumption that statistical characteristics of the data are relatively unchanged unless the malfunction event occurs in the system. Prognostics uses this approach for a statistical and learning technique from the theory of pattern recognition.

Model-based prognostics

Using an accurate mathematical model, this check can be performed between its outputs and measurements from sensors. Residuals are calculated and their values are used to detect signs of the system malfunction. However, this is more effective for smaller systems as an analytical approach requires a detailed quantitative mathematical model. For larger systems it can be expensive and time consuming.

Knowledge-based prognostics

This type of prognostics can be made based on a causal analysis, expert systems and pattern recognition. The first one is based on modelling fault-symptom relationships. Expert system can be formulated as IF-THEN rules, which mimics a troubleshooting that is done by an experienced engineer not requiring him to be present for consultation.

Diagnostics

This can be related to fault, abnormality or failure detection. The advanced gas turbine health monitoring system should allow an incipient fault detection. The severity of a fault will usually increase over time with the equipment usage. An early root cause analysis can reduce the impact of a fault on the system operation. Detecting signs of the system malfunction at an early stage can be used not only to plan an earlier part replacement, but also to change from the operation method. It can help to minimize the risk of an abnormality developing into a catastrophic failure at an early stage of the operation. For example, if the gearbox gear's excessive wear is detected using the vibration analysis the control system can reduce work extracted from the shaft, which reduces the risk of a catastrophic failure of the gearbox as gears will work at lower forces. This may give the user extra time to order a replacement part and schedule an equipment shutdown for overhaul.

Vocabulary:

1. To refer to – ссылаться на, означать
2. Abnormality - аномалия
3. An estimation - оценка
4. Engine wear & tear - износ двигателя
5. A prediction of faults - прогноз неисправности
6. To predict the health – прогнозировать состояние
7. To rely on – полагаться на
8. A degradation curve - кривая деградации
9. Data-driven method – метод, основанный на данных
10. Model-based – на основе моделей

11. An assumption - предположение
12. Approach - подход
13. Technique - метод
14. Recognition - распознавание
15. Residual - остаток
16. Value - значение
17. Sign – знак, признак
18. •Knowledge-based – основанный на знаниях
19. Causal analysis - причинно-следственный анализ
20. Relationships - отношения
21. A troubleshooting - устранение неисправностей
22. An experienced engineer – опытный инженер
23. Incipient - зарождающийся
24. To reduce - уменьшать
25. Impact - воздействие
26. A Gearbox – коробка приводов
27. Excessive wear - чрезмерный износ
28. Overhaul – капитальный ремонт

Exercise 1. Answer the following questions:

1. What are the two main functions of the advanced gas turbine monitoring system?
2. What is at the foundation of Condition Based Maintenance?
3. What is needed to plot the degradation curve of a component?
4. How can prognostic methods be classified?
5. What does data-driven method rely on?
6. How does model-based method work?
7. Will you explain the main idea of knowledge-based prognostics method?
8. What can reduce the impact of a fault on the system operation?
9. How can detecting signs of the system malfunction at an early stage be used?
10. What are the advantages of excessive wear detection at an early stage?

Exercise 2. Read and translate the following word combinations:

To detect present and past abnormalities, to allow an estimation of the engine wear and tear, a prediction of faults, to rely on the current health assessment, to plot the degradation curve, failure prediction, •data-driven prognostics, to rely on the assumption, learning technique, pattern recognition, an accurate mathematical model, to detect signs of the system malfunction, analytical approach, to be expensive and time consuming, to be based on a causal analysis, pattern recognition, modelling fault-symptom relationships, to mimic a troubleshooting, an experienced engineer, failure detection, to allow an incipient fault detection, severity of a fault, equipment usage, to reduce the impact of a fault, to plan an earlier part replacement, to develop into a catastrophic failure, excessive wear, time to order a replacement part, to schedule an equipment shutdown for overhaul.

Exercise 3. Find in the text English equivalents to the following expressions:

Оценить износ двигателя, предсказать неисправности, текущая оценка технического состояния, построение кривой деградации, прогнозировать время до отказа, методы прогнозирования, на основе теории распознавания образов, вычислять остатки, использовать значения, обнаружить признаки неисправности системы, на основе причинно-следственного анализа, имитировать устранение неисправностей, обеспечивать обнаружение зарождающихся неисправностей, степень тяжести неисправности, ранний анализ первопричин, уменьшить влияние сбоя на работу системы, планирование более ранней замены деталей, изменение условий эксплуатации, минимизировать риск, перерастать в катастрофический сбой, на ранней стадии эксплуатации, чрезмерный износ, дать пользователю дополнительное время, заказать запасную часть, запланировать остановку оборудования на капитальный ремонт.

Exercise 4. Make up all possible types of questions:

1. The severity of a fault will usually increase over time with the equipment usage.
2. Detecting signs of the system malfunction at an early stage can be used not only to plan an earlier part replacement, but also to change from the operation method.
3. An analytical approach requires a detailed quantitative mathematical model.
4. Residuals are calculated and their values are used to detect signs of the system malfunction.
5. This may give the user extra time to order a replacement part and schedule an equipment shutdown for overhaul.

Exercise 5. Translate the following sentences into English:

1. Способность прогнозировать состояние компонента машины через какое-то время лежит в основе обслуживания по техническому состоянию.
2. Кривая деградации компонента позволяет прогнозировать время до отказа.
3. Методы прогнозирования можно классифицировать как основанные на данных и на моделировании.
4. Аналитический подход требует наличия подробной количественной математической модели.
5. Система должна обеспечивать обнаружение зарождающихся неисправностей.

6. Ранний анализ первопричин может уменьшить влияние сбоя на работу системы.

7. Обнаружение признаков неисправности системы на ранней стадии может быть использовано не только для планирования более ранней замены деталей, но и для изменения условий эксплуатации.

Exercise 6. Find in the text the sentences with the verbs in the Passive Voice, explain their usage.

Exercise 7. Read the following international words. Define their meanings comparing them to the meanings of the corresponding Russian words:

Diagnostics, prognostics, function, machine, component, degradation, characteristics, technique, theory, model, calculation, expert, symptom, analysis, operation, plan, method, catastrophic, vibration, user.

Unit 6.

Read and translate the text:

CONDITION BASED MAINTENANCE

The concept of a condition based maintenance is well known in industry. It proposes a maintenance regime based on the equipment condition rather than on the hourly operation schedule. Engine performance will deteriorate over time reducing the amount of work that can be extracted from the shaft. This will happen due to the reduced compressor efficiency. Air mass flow will decrease at designed compressor speed because of engine degradation. Sources of degradation in the engines are well known (fouling, erosion, hot corrosion, internal liner surface cracking, increase in the tip and seal clearance, contamination, plugging of the injector and the cooling holes). The velocity of these processes will be different depending on the manufacturing tolerance and is strongly associated with the engine operating conditions such as the atmospheric conditions and the engine operation regime (full or partial load, frequency of start & stop cycles, type and quality of fuel). These variables would mean that degradation curves of two similar engines will never be identical and the maintenance based on the operation hours of the machinery is inaccurate, exposing user to avoidable costs, downtime and finally a reduced production. From the user's perspective, too frequent preventive maintenance inspections on the equipment can also have a negative effect on reliability due to maintenance-induced faults.

The main advantages of this approach are a reduced operation cost and a higher availability as it allows operator to better plan maintenance.

A similar method of monitoring gas turbine performance can be applied to other equipment such as actuators if a sufficient number of sensors is available. Valves can be condition monitored not only to confirm if open/close transition is made in a designed time period but also to detect wear by establishing the trajectory of degradation (performance-versus-time plot). A valve used for the fuel flow control can be monitored for a deposit build-up due to impure fuel. This will affect flow thereby monitoring the pressure drop on this valve at a given percentage opening. If this relation deviates too great an early scheduled overhaul should be performed before the valve fails.

Gas Path Analysis

This common method in evaluating AGTHMS relies on a thermodynamic analysis of the gas path and of the energy balance. Using existing sensors for: air/gas flow, atmospheric pressure, intake/exhaust temperature, combustion temperature spread, shaft rotational speed and power generated on the shaft. This information could be used to detect: ineffective operation, compressor and turbine fouling, foreign object damage, filter clogging, plugged nozzles, worn seals, excessive blade and nozzles tip clearance.

This is based on an assumption that most faults in a gas turbine will show up or leave signature in the performance of the component exposed to the air/gas flow passing through the engine.

Direct analysis of thermodynamic data

The first step of the analysis is to observe the engine output data under normal operating conditions at given speed and power. The second step is to calculate deviations of the readings over time, providing both the magnitude and the rate of changes. The greatest advantage of this method is its straightforward implementation; however, this approach can help to rectify only the previous known faults. To overcome this drawback an additional implementation of the engine model, which has a fault simulation signature is suggested.

Vocabulary:

1. To deteriorate - ухудшаться
2. To decrease - уменьшать
3. Sources - источники
4. Fouling – замасливание, неполадки
5. Crack - трещина
6. Contamination - загрязнение
7. Seal – уплотняющая прокладка, герметик
8. Plugging - закупорка
9. A variable - переменная
10. Inaccurate - неточный
11. Avoidable – не неизбежный, то, чего можно избежать
12. Downtime - простой
13. Preventive - профилактический
14. Reliability - надежность
15. Availability - доступность
16. Impure fuel – топливо с примесью
17. To deviate - отклоняться

18. Exhaust – выхлоп, выходное устройство
19. Foreign object – посторонний предмет
20. Clogging - засорение
21. Magnitude - величина
22. Implementation – реализация, выполнение

Exercise 1. Answer the following questions:

1. What does a condition-based maintenance propose?
2. What will engine performance reduction lead to?
3. What are the sources of degradation in the engines?
4. What does the degradation processes velocity depend on?
5. Why can too frequent preventive maintenance inspections on the equipment have a negative effect on reliability?
6. What are the main advantages of the condition-based maintenance?
7. What information is needed to detect ineffective operation, compressor and turbine fouling, foreign object damage?
8. What are the advantages and drawbacks of the direct analyses of thermodynamic data?

Exercise 2. Read and translate the following word combinations:

condition based maintenance, equipment condition, hourly operation schedule, engine performance, reduced compressor efficiency, engine degradation, sources of degradation, plugging of the injector, cooling holes, manufacturing tolerance, preventive maintenance inspections, reduced operation cost, higher availability, due to impure fuel, an early scheduled overhaul, exhaust temperature, shaft rotational speed, to detect: ineffective operation, compressor and turbine fouling, foreign object damage, filter clogging, plugged nozzles, worn seals, to calculate deviations of the readings, to overcome the drawback.

Exercise 3. Find in the text English equivalents to the following:

стратегия технического обслуживания; производительность двигателя; техническое обслуживание, основанное на состоянии; снижение эффективности компрессора; сокращение объема работ; плановый капитальный ремонт клапана; отслеживать падение давления; загрязненное топливо; регулирование расхода топлива; расчетный период времени; обнаружение износа; контроль работоспособности газовых турбин; снижение эксплуатационных расходов; закупоривание инжектора; полная или частичная нагрузка; частота циклов пуска-остановки; тип и качество топлива; столкнуться с расходами, которых можно избежать; слишком частые профилактические осмотры оборудования; обнаружить неэффективную работу; загрязнение компрессора и турбины; повреждения посторонними предметами; засорение фильтра; изношенные уплотнения; вычислить отклонения показаний.

Exercise 4. Make up all possible types of questions:

1. Air mass flow will decrease at designed compressor speed because of engine degradation.
2. Method of advanced gas turbine health monitoring system evaluation relies on a thermodynamic analysis of the gas path and of the energy balance.
3. The greatest advantage of this method is its straightforward implementation.
4. This approach can help to rectify only the previous known faults.
5. Artificial Neural Networks have been a powerful tool in estimating gas turbines performance and fault detection.

Exercise 5. Translate the following sentences into English:

1. Стратегия технического обслуживания по состоянию хорошо известна в авиационной индустрии.
2. Слишком частые профилактические осмотры оборудования могут отрицательно сказаться на его надежности из-за неисправностей, вызванных ошибками в ходе технического обслуживания.
3. Клапан, используемый для регулирования расхода топлива, может контролироваться на наличие отложений, вызванных загрязненным топливом.
4. Этот метод основан на предположении, что большая часть неисправностей в газовой турбине проявится в работе компонента, подвергающегося воздействию потока воздуха, проходящего через двигатель.
5. Первым этапом анализа является наблюдение за выходными данными двигателя при нормальных условиях работы при заданных частоте вращения и мощности.
6. На втором этапе вычисляются отклонения показаний с течением времени с учетом как величины, так и скорости изменений.
7. Наибольшим преимуществом этого метода является его простая реализация.

Exercise 6. Make verbs from the following nouns:

Noun	Verb
performance	
evaluation	
implementation	
requirement	
decision	
contamination	
measurement	
clearance	
combination	
reliability	
deviation	

Exercise 7. Read, translate and retell the following text:

Aircraft engines produce the power needed for aircraft. For this reason, aircraft engines are very important for flight safety. Today's complex and advanced technology systems require advanced and expensive maintenance strategies. Maintenance services are costly for airline companies. For manufacturers, maintenance is a source of revenue.

Because of the high cost of maintenance, gas turbine engines must be operated within specified physical limits. Today's aircraft engines are made safer by increasing the number of control parameters and sensors. The engines have a complex mechanical system. Because aircraft engines operate at high temperatures, high pressures, and high speeds, there are lots of possibilities of various faults in the aircraft. Gas turbine engines show the effects of wear and tear over time. A small fault during the flight does not prevent the engine from running, but if this fault is not detected, it could lead to a bigger fault. If these bigger faults cannot be prevented in the aircraft, it can lead to high maintenance costs and accidents. When aircraft are taken for maintenance, the condition of the gas turbine engine is investigated by various tests and measurements. Condition-based maintenance (CBM) is being performed to provide effective and efficient maintenance in today's maintenance services.

Unit 7.

Read and translate the text:

Corrosion and Corrosion Control in Aviation

A commercial airplane is designed and operated for maximum yield, i.e., capacity to deliver (e. g., expressed as passenger km) as a function of operating and capital costs. Among attributes contributing to an aircraft yield are its size, shape, speed, mass, and fuel efficiency. Some of these are constrained by aerodynamic considerations and external factors but mass and fuel efficiency are strongly influenced by the selection and application of the materials of construction.

The importance of minimizing mass is illustrated by a specific example. The take-off mass of a typical fully laden wide-body passenger aircraft is 370 tons, comprising 160 tons of structure including engines, 170 tons of fuel but only 40 tons of payload. Mass saved in the structure can be either transferred to the payload or used to secure some alternative economic benefit. Since the mass ratio of the structure to the payload is four, the effect of increments in mass on yield is magnified in proportion, e.g., a 1% change in mass theoretically produces a 4% change in yield. Therefore all contributions to mass are scrutinized. For example, metal sections and thicknesses are the reasonable minima needed to carry the maximum anticipated stresses safely and excessive structural reserves to compensate for avoidable corrosion are unacceptable. Even protective coatings, such as paints, contribute some mass and must be applied with discrimination. It is within this context that resistance to corrosion and other degradation agencies must be considered.

The control of corrosion has various implications:

1. Safety is paramount and corrosion damage must not initiate
structural failure in flight.

2. Aircraft represent heavy capital investment that must beъprotected; the costs of degradation and rectification must be within allowances made in planned amortization.

3. Airline schedules must not be disrupted through unplanned
grounding.

These requirements must be met in the competitive context of airline operations and under the supervision of aviation authorities acting in the public interest such as the FAA and their equivalents in other countries.

This imposes strict disciplines on the selection, fabrication, surface treatment and service history records of the structural materials.

Vocabulary:

1. Yield – доходность, производительность
2. Capacity – емкость, способность
3. To deliver - доставлять
4. Capital costs – капитальные затраты
5. Attribute – признак
6. To contribute - способствовать
7. Shape - форма
8. To constrain - ограничивать
9. Considerations - соображения
10. Application - применение
11. Fully laden – полностью загруженный
12. To comprise – включать, охватывать
13. Payload – полезная загрузка
14. Benefit – выгода, прибыль
15. Increment - приращение
16. To magnify - увеличить
17. Contribution - вклад
18. To scrutinize – тщательно изучать
19. Thickness - толщина
20. To anticipate - предвидеть
21. Coating - покрытие
22. Resistance - сопротивление
23. Implication – вовлечение, причастность
24. To impose - налагать

Exercise 1. Answer the following questions:

1. Will you explain the meaning of the term “yield”?
2. What are some of the attributes contributing to an aircraft yield?
3. What is strongly influenced by the selection and application of the materials of construction?

4. Why is it important to minimize aircraft take-off mass?
5. Why are all contributions to aircraft take-off mass scrutinized?
6. Why must protective coatings be applied with discrimination?
7. What are the requirements to the aircraft corrosion control?

Exercise 2. Read and translate the following word combinations:

maximum yield, capital costs, to contribute to an aircraft yield, fuel efficiency, to be constrained by aerodynamic considerations, external factors, to be strongly influenced, fully laden wide-body passenger aircraft, to comprise 160 tonnes, to secure some alternative economic benefit, ratio of the structure to the payload, to be magnified in proportion, reasonable minima, anticipated stresses, excessive structural reserves, avoidable corrosion, protective coating, to be applied with discrimination, resistance to corrosion, the costs of degradation and rectification, under the supervision of aviation authorities.

Exercise 3. Find in the text English equivalents to the following:

Коррозионное повреждение, серьезное капиталовложение, затраты на устранение последствий старения и ремонт, непредвиденные причины, налагать строгие границы, максимальная прибыль, топливная экономичность, широкофюзеляжный пассажирский самолет, полезная загрузка, отношение массы конструкции к массе полезного груза, разумные минимумы, выдерживать максимальные ожидаемые усилия безопасно, защитные покрытия, минимальная толщина, процессы старения.

Exercise 4. Make up all possible types of questions:

1. The control of corrosion has various implications.
2. Corrosion damage must not initiate structural damage in flight.
3. The Investigation concluded that the ATC procedure involved was potentially hazardous.
4. The major concern of aviation industry is safety of flight.
5. The airplane engine will burn off a certain amount of fuel during operation.

Exercise 5. Translate the following sentences into English:

1. Среди признаков, способствующих прибыльности самолета - его размер, форма, скорость, масса и топливная экономичность.
2. На массу и топливную экономичность самолета сильное влияние оказывает выбор и применение различных конструкционных материалов.
3. Коммерческий самолет разрабатывается и эксплуатируется для максимальной прибыли.
4. Защитные покрытия, такие как краски, вносят некоторую массу и должны быть применены с минимальной толщиной.
5. Графики авиакомпании не должны быть сорваны по непредвиденным причинам.
6. Коррозионное повреждение не должно привести к разрушению

конструкции самолета в полете.

Exercise 6. Find in the text the sentences with the verbs in the Passive Voice, explain their usage.

Exercise 7. Give the three forms of all the verbs used in the text.

Exercise 8. Read, translate and retell the following text:

The average age of the aircraft in use today is getting older. Many mechanics are maintaining aged aircraft and fleets that have special inspection and maintenance needs. Although there are many issues to consider when working with older aircraft, the most insidious of these is corrosion. It can slowly progress and become well established before being detected. Just as cancer can be devastating to the human body, corrosion can spread to adjacent structure at a rapid pace once it takes hold. It can lead to fatigue, weakened structure, and have a catastrophic impact on public safety. Early detection and treatment are essential to controlling corrosion.

Unit 8.

Read and translate the text:

Airframes. Materials of Construction

For economy in mass, cost benefit analysis reveals that the most desirable properties of airframe materials are low density, high modulus, and damage tolerance. Following years of experience, the materials that best meet these requirements are the age-hardening aluminum alloys in the AA 2000 and AA 7000 series, particularly AA 2024, and AA 7075 alloys. Typically, fuselage skins are fabricated from rolled sheet of the more damage-tolerant alloy, AA 2024, supported on frames usually made from the stronger alloy AA 7075. A modern practice is to machine wings to shape from AA 2024 alloy plate to produce integral stiffeners and to optimize mass by varying the thickness to keep stress levels consistent. There is some replacement of aluminum alloys by carbon fiber composites where the imposed stress system is suitable. Aluminum alloys containing lithium offer density and modulus advantages for possible future use but they are not generally accepted for aircraft at present, although they are applied in space vehicles.

Corrosion of Aluminum Alloys in Airframes

Water causing corrosion on the inside of the fuselage structure is accumulated from vapor from human sources condensing against the cold skin and where insulating materials can obstruct drainage. The corrosion is insidious, developing out of sight and eating into structural reserves. The decisive criterion is area loss, reducing the ability of the material to ½ transfer loads correctly within the structure. It is unusual to find substantial damage on open flat panels and corrosion is generally associated with specific features of the structure.

Corrosion around faying surfaces, rivets, joints, and crevices is particularly troublesome. The incidence and severity of corrosion in these places is sensitive to details of construction. Errors in assembly that encourage corrosion include:

1. Crevices between fuselage skins and frames
2. Dry, i.e., unsealed, joint assembly.
3. Gaps where sealant fails to protect interfaces between multiple skins applied to reduce stress levels around cut-outs such as door-frames.
4. Stringer sections disposed so as to form gravity traps for water. Based on experience, designs and construction techniques have been modified to reduce corrosion damage.

These expedients include:

1. Eliminating multiple skins at cut-outs, by providing the extra thickness needed for reinforcement from thicker sheets, profiled by chemical milling.
2. Provision of drainage holes closed by spring-loaded valves to prevent accumulation of water at critical places.
3. Assembly of joints with sealants to prevent ingress of water. Certain zones are corrosion free. Examples are the insides of pylon box sections that are heated by the engines.

The whole of each wing structure forms a fuel tank and it inevitably collects water through the temperature and humidity cycles experienced. If the water remained, there would be a possible biological corrosion hazard by the growth of a fungus at the water/fuel interface that generates acids.

In modern aircraft, any such problem is eliminated by *sump pumping* the fuel from low remote points in the tank where any water could collect; this extracts the water and delivers it harmlessly to the engines. Provided that this is done, there are no residual corrosion problems on the insides of wings.

External Corrosion. Corrosion of Aluminum Structures

At low altitudes, the airframe is exposed to the natural atmosphere; it can be made more aggressive locally by chlorides contributed from de-icing salts and marine environments. Nevertheless, the general corrosion on the outside is less than on the inside except in particular areas where it can be quite severe on some aircraft.

The vulnerable areas include the external forward faces of the front and rear wing spars and undercarriage bases; this may be associated with erosion-corrosion induced by the airflow. External damage is easier to detect and rectify than internal corrosion.

Corrosion of Steel Components

Where necessary, some airframe fittings are made from high strength steel, protected by electrodeposited coatings of cadmium for bi-metallic compatibility with aluminum alloys. They include flap-track fittings and pylon pins together with their terminating attachment points that unite the engines with the wings. Corrosion of these components would be particularly serious and must be monitored carefully and rectified because of possible interference with their vital functions.

Vocabulary:

1. Property - свойство
2. Density - плотность
3. Damage-tolerant – терпимый к повреждению
4. Stiffener – элемент жесткости
5. Aluminum alloy – алюминиевый сплав
6. Thickness - толщина
7. Vapor - испарение
8. Drainage – дренаж, выпуск жидкости
9. Insidious – коварный, скрытый
10. Substantial damage – значительное повреждение
11. A rivet - заклепка
12. Joint – место соединения
13. Crevice - щель
14. Sealant – герметик, материал для уплотнений
15. Gravity trap - отстойник
16. Expedient – целесообразный, подходящий
17. Reinforcement – усиление, укрепление
18. Humidity - влажность
19. Harmlessly – без ущерба
20. Residual - остаточный
21. Vulnerable - уязвимый
22. Compatibility – совместимость, сочетание
23. Interference – вмешательство, помеха

Exercise 1. Answer the following questions:

1. What are the most desirable properties of airframe materials?
2. What are the materials that best meet all the requirements?
3. Where is water causing corrosion on the inside of the fuselage structure accumulated from?
4. What damage can the corrosion inside the fuselage structure cause?
5. What is corrosion generally associated with?
6. Where is corrosion particularly troublesome?
7. What sort of errors can encourage corrosion?
8. What has been done to reduce corrosion damage?
9. What zones are corrosion free?
10. What can cause corrosion damage in a wing structure?
11. What problem is eliminated by sump pumping in modern aircraft?
12. What are the external vulnerable areas of the aircraft?
13. What are some airframes fittings made of?

Exercise 2. Read and translate the following word combinations:

cost benefit analysis, the most desirable properties, low density, high modulus, damage tolerance, meet the requirements, age-hardening aluminium alloy, to be fabricated from rolled sheet, to produce integral stiffeners, to keep stress levels consistent, carbon fiber composites, insulating materials, to develop out of sight, area loss, to find substantial damage, corrosion around faying surfaces, errors in assembly, to protect interfaces between multiple skins, to form gravity traps for water, to provide extra thickness, to prevent accumulation of water, humidity cycles, to be eliminated by sump pumping, residual corrosion problems.

Exercise 3. Find in the text English equivalents to the following:

Удовлетворять требованиям, терпимость к повреждениям, низкая плотность, сплав алюминия дисперсионного отвердения, изготовить из прокатного листового железа, соединения углеволокна, производить составные жесткие подкладки, анализ эффективности затрат, самые желательные свойства, изоляционные материалы, ошибки при сборке, предотвращать накопление воды, коррозия вокруг плотно прилегающих поверхностей, развиваться невидимо для глаз, потеря площади, уменьшить повреждаемость коррозией, устранять с помощью системы откачки, остаточные коррозионные поражения, сталь высокой прочности.

Exercise 4. Make up all possible types of questions:

1. At low altitudes, the airframe is exposed to the natural atmosphere.
2. Aluminum alloys containing lithium offer density and modulus advantages for possible future use.
3. Designs and construction techniques have been modified to reduce corrosion damage.
4. . Corrosion of these components would be particularly serious.
5. Cost benefit analysis reveals that the most desirable properties of airframe materials are low density and damage tolerance.

Exercise 5. Translate the following sentences into English:

1. Анализ эффективности затрат показывает, что самые желательные свойства материалов планера – это низкая плотность, высокий модуль прочности и терпимость к повреждениям.
2. Алюминиевые сплавы, содержащие литий, дают преимущества в плотности и прочности для возможного будущего использования, но они не распространены в самолетостроении в настоящее время, хотя и применяются в космических кораблях.
3. Коррозия коварна, она развивается невидимо для глаз, разрушая конструкционные резервы самолета.
4. Коррозионное повреждение нечасто обнаруживается на открытых плоских панелях, и развитию коррозии обычно способствуют определенные особенности структуры конструкционного материала.
5. Коррозия вокруг подвижных поверхностей, заклепок, сочленений и щелей особенно неприятна.

6. Основываясь на опыте, конструкторские и технологические методы были изменены, чтобы уменьшить повреждаемость
коррозией.

7. Конструкция каждого крыла формирует топливный бак, и она неизбежно собирает воду из-за температурных и влажностных циклов.

Exercise 6. Match the words on the left with their Russian equivalents on the right.

1. drainage	a) производитель
2. development	b) значительный
3. interference	c) толщина
4. tolerance	d) разработка
5. density	e) терпимость
6. attachment	f) плотность
7. passivation	g) дополнение
8. coating	h) вмешательство
9. compatibility	i) дренаж
10. manufacturer	j) создание защитного слоя
11. thickness	k) покрытие
12. substantial	l) совместимость

Exercise 7. Form nouns from the verbs:

To desire, to require, to replace, to drain, to construct, to reinforce, to accumulate, to erode, to corrode, to fit, to attach, to interfere, to rectify, to contribute, to deliver, to provide, to reduce, to decide.

Exercise 8. Find in the text the nouns with the suffixes –or, -er, -tion, -sion, -ence and say what verbs they are derived from.

Exercise 9. Read, translate and retell the following text:

What is corrosion?

The Dictionary of Aeronautical Terms defines corrosion as "an electrolytic action which takes place inside a metal or on its surface. The metal reacts with an electrolyte, and part of the metal is changed into a salt. The salt, which is the corrosion, is usually dry and powdery, and it has no strength."

Four factors are needed for corrosion to exist:

1. Presence of a metal that will corrode (anode).

2. Presence of a dissimilar conductive material (cathode) which has less tendency to corrode.

3. Presence of a conductive liquid (electrolyte).

4. Electrical contact between the anode and cathode (usually metal-to-metal contact, or a fastener). Elimination of any of these factors will stop corrosion.

READER

Text 1

Risk View of New Advanced Gas Turbines and Their Technologies

The benefits of advanced gas turbines and their technologies are easily quantified. The gas turbines produce more power, use less fuel, provide higher combined cycle efficiencies, and reduce emissions levels significantly. So why is the insurance industry concerned? Because, when you step back and examine where new turbines are today versus where they were previously, there is a significant down side. In particular:

• New advanced turbines are run at higher firing temperatures, are physically larger in size, have larger throughput (airflows and fuel flows), and have higher loadings (pressure and expansion ratios, fewer airfoils, larger diameters) than previous gas turbine designs.

• The technologies (design, materials, and coatings) required to achieve the benefits are more complex to concurrently meet gas turbine performance, emissions, and life requirements.

• The design margins with these technologies tend to be reduced or invalidated. While analytical models may be extrapolated to evaluate the new designs, full-scale verification of the new designs is an absolute necessity. Similarly, the materials being used are either relatively new or are being pushed to new limits.

• There is no reliability record for the new designs. While component rig testing (scale or sector) may help validate some component's performance, the first time the unit reaches design conditions is in the owner's plant. Essentially, the units are considered prototype or unproven designs for the first three years of operation or until all the major design problems are identified and corrected.

• The cost of hardware and subsequent cost of ownership have increased due to the complex designs, increased size, and higher throughput in the advanced machines.

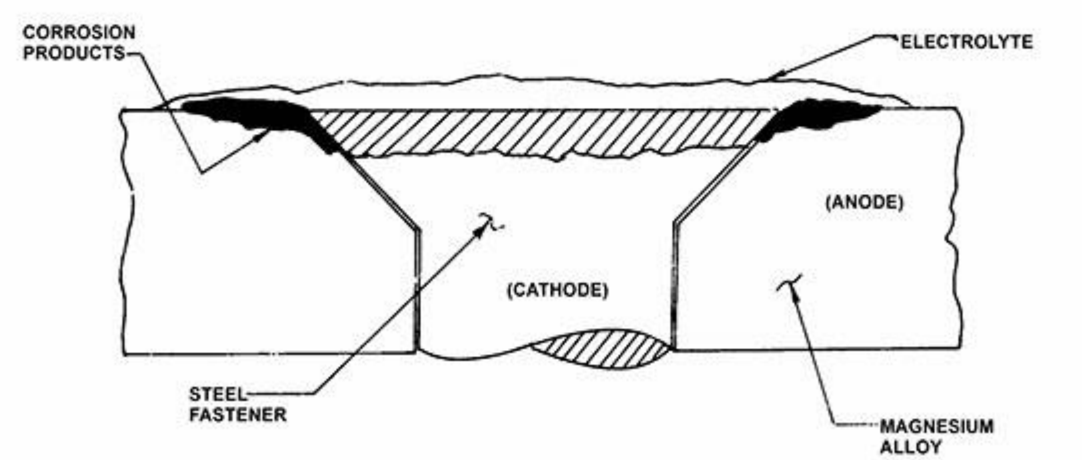
. • Gas turbine operation has similarly become more complex and computer driven requiring new/different skill sets for staffing in plants.

Text 2.

Know the enemy

Corrosion, or at least the type what we typically deal with is simply the electromechanical deterioration of a base metal caused by a chemical reaction to its surroundings – air and water. Unfortunately, many of the metals that make up a typical airframe are prone to corrosion. And the situation can be made even worse wherever two dissimilar metals meet.

"Any time you have two dissimilar metals touching and you introduce moisture, the least noble of the two materials is going to corrode. That's just a given," stated Mark Pearson, general manager and owner, Lear Chemical Research Corporation. "And the more you operate in areas with high humidity, salt, heat and airborne pollutants, the faster that corrosion will accelerate." In fact, many experts believe that corrosion begins the moment the aircraft is assembled. Processed metals are in an unstable format. With the help of an electrolyte, they want to revert back to their original stable oxide form.



Pic.1.Galvanic corrosion occurs when two dissimilar metals make contact in the presence of an electrolyte. It is usually recognizable by the presence of a build-up of corrosion at the joint between the metals.

The specialists have been using various barrier coatings like paint and zinc chromate to protect internal components for decades. While their steps do slow the process, zinc chromates and paints eventually become brittle and come away from the base metals. Once the barrier coating wears off, the corrosion switch is turned on. When corrosion appears in lap joints and around rivets and screws, technicians have to be ever more proactive in their ongoing inspections and the implementation of a program that will keep moisture out of the damaged areas.

As Pearson said, in its most basic form, airframe corrosion is the electrolytic destruction of metal by an electrochemical reaction with its environment. If we could view a corrosion 'cell' at a microscopic level we see all the elements of a battery – you have an anode, a cathode, a path of current and an electrolyte such as water that's laced with a bit of salt, dirt, exhaust or other airborne contaminant. The introduction of the latter completes the 'circuit,' which causes the transfer of electrons to create corrosion between the two metals.

Technicians: The First Line of Defense

"We've been developing and manufacturing corrosion control processes and products longer than anyone and experience has shown that mitigation or prevention is critical to corrosion control efforts," Pearson said. "Prevention is far better than trying to find a cure after corrosion has established itself in the aircraft. A preventative maintenance program is the least expensive and most effective way you can have to minimize corrosion."

"To that end, technicians are extremely important in the ongoing battle to control airframe corrosion," he continued. "They need to be doing every inspection with the intent to find signs of corrosion – especially in older aircraft. Borescopes and other tools are invaluable in helping technicians see under floorboards, behind pressure bulkheads and other tight spaces that are prone to holding a lot of moisture and contaminants."

Словарь терминов

№ п/п	Термин	Перевод
1	capacity	емкость, вместимость
2	fuel efficiency	топливная экономичность
3	aerodynamic considerations	аэродинамические соображения
4	take-off mass	масса взлета
5	fully laden wide-body passenger aircraft	полностью загруженный широкофюзеляжный пассажирский самолет
6	payload	полезный груз
7	scrutinize	тщательно изучать
8	avoidable corrosion	устранимая коррозия
9	protective coating	защитное покрытие
10	resistance to corrosion	устойчивость к коррозии
11	degradation agencies	процессы старения
12	corrosion damage	коррозионное поражение
13	paramount	чрезвычайно важный
14	structural failure	разрушение конструкции
15	heavy capital investment	значительные капиталовложения
16	rectification	исправление, устранение
17	airline schedules	графики (расписание) авиалиний
18	disrupt	сорвать
19	unplanned grounding	Незапланированное запрещение полетов
20	requirement	требование

21	supervision of aviation authorities	под наблюдением авиационных властей
22	service history records	история технического обслуживания
23	airframe	планер
24	desirable properties	предпочтительные характеристики
25	low density	низкая плотность
26	high modulus	высокий модуль прочности
27	damage-tolerance	терпимость к повреждениям
28	age-hardening aluminum alloys	сплавы алюминия дисперсионного отвердения
29	fuselage skin	обшивка фюзеляжа
30	rolled sheet	листовой прокат
31	machine wings	производить крылья
32	integral stiffeners	составные жесткие подкладки
33	carbon fiber	соединения углеволокна
34	imposed stress system	наложенная система напряжения
35	lithium	литий
36	space vehicles	космические аппараты
37	high copper and zinc contents	высокое содержание меди и цинка
38	natural passivation of aluminum	естественная пассивация алюминия
39	surface coatings	поверхностные покрытия
40	roll-bonded cladding	Нанесенная на рулон оболочка
41	metal manufacturer	производитель металла
42	galvanic protection	гальваническая защита
43	sheet thickness	толщина листа
44	machined surfaces	обработанные поверхности
45	paint protection	защита покраской
46	chromate-inhibited primer	хромат-ингибированная грунтовка
47	electrostatic guided spray	электростатически управляемое распыление жидкости
48	implementation	внедрение
49	sulfuric or phosphoric acid	серная или фосфорная кислота
50	shot-peening	дробеструйная обработка

51	fuselage	фюзеляж
52	vapor	пар
53	insulating materials	изоляционные материалы
54	obstruct drainage	затруднить дренаж
55	insidious	коварный
56	structural reserves	структурные резервы
57	substantial damage	серьезное повреждение
58	rivet	заклепка
59	joints	сочленения
60	crevice	щель
61	evaluation of data	оценка данных
62	stringer	стрингер
63	gravity traps	гравитационные ловушки
64	eliminating multiple skins at cut-outs	устранение многократных слоев обшивки в контурах
65	chemical milling	химическое фрезерование
66	spring-loaded valve	подпружиненный клапан
67	pylon box sections	отсеки пилона
68	fuel tank	топливный бак
69	inevitably	неизбежно
70	temperature and humidity cycles	температурные и влажностные циклы
71	biological corrosion hazard	угроза биологической коррозии
72	incipient	зарождающийся
73	sump pumping	перекачка отходов
74	low altitudes	низкие высоты
75	de-icing	противообледенительная обработка
76	vulnerable areas	уязвимые области
77	wing spars	лонжероны крыла
78	undercarriage bases	основания шасси
79	erosion-corrosion	коррозия в результате эрозии
80	air flow	поток воздуха
81	high strength steel	высокопрочная сталь
82	enhanced arrangement	усовершенствованная компоновка
83	compatibility	совместимость
84	flap-track fittings	фиттинги направляющих

		закрылков
85	pylon pins	шпильки пилонов
86	local fatigue cracking	местное усталостное разрушение
87	joint-penetrating	проникновение в трещины
88	water-repellant	водоотталкивающий
89	long-term protection	долгосрочная защита
90	environmentally sensitive cracking	Разрушение, чувствительное к параметрам окружающей среды
91	fatigue cracking	усталостное разрушение
92	cyclic stresses	циклические нагрузки
93	flight maneuver loads	нагрузки при маневрах в полете
94	gust load	нагрузка от воздушного порыва
95	pressurization	разгерметизация
96	markings on fractures	маркировка на надломах
97	stress-corrosion cracking	Коррозионное растрескивание
98	heat treatment procedures	Процедуры термической обработки
99	nozzle	сопло

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