DRAFT AMENDMENT MPM USING UNCONVENTIONAL TECHNOLOGIES

Miroslava Cúttová – Peter Mrva

The text includes problematic about increase life of the jet engine MPM-20 with application of protective coating on hot parts of the engine. It deals with choosing technology in terms of requirements with editing surface of material and with choosing materials in terms of structure and chemical composition. The next section discusses about technology- thermal plasma spraying, with which spread by the desired layer of protective coating (metal and coating) on the surface of engine MPM-20, ensuring thus increasing its durability and protection against corrosion and wear.

K e y w o r d s: jet engine, protective coating, thermal plasma spraying

1 INTRODUCTION

Purpose of this text is the application of appropriate protective coatings on the hot parts of the jet engine MPM-20 in order to increase its life. The first part is devoted to the construction of engine parts. Base of this work is coating than the next section is devoted to the description of the technology of creating protective coatings and described materials. After describing the technology and materials, we choose appropriate technology and materials to create high quality coating that is applied to jet engine MPM-20. The coating is applied mainly to the parts which are the most thermally stressed. At the end we created a scheme for engine MPM-20 that shows the suitable materials for increase its life by using coatings.

2 CHARACTERISTIC OF THE ENGINE MPM-20

Construction modifications of turbine starter TS-20 created small, single, air, jet engine MPM-20 (Figure 1). Turbine starter TS-20 was originally used to spin the rotor jet engine on the ground, during take off and conservation. It has been adapted to the needs of the experimental measurements. Currently it is located in the premises of the Faculty of Aeronautics Technical University of Kosice. TS-20 is engine which is suitable for laboratory measurements due to its small size and its characteristics are very similar to the large dimension of the engines.

Figure 1 Jet engine MPM-20

Engine MPM-20 is engine with radial compressor with single impeller, combustion chamber, axial, uncooled gas turbine reaction type and output system with fixed outlet nozzle. The scheme MPM-20 can be seen in Figure 2.

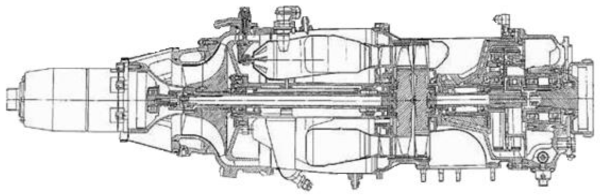

Figure 2 Scheme MPM-20

The input system of the engine ensures fluent supply amount of air from the atmosphere to enter the compressor (in our case to the radial compressor). Radial compressor is used to compress the incoming air from input system and its delivery to the combustion chamber. The combustion chamber provides chemical conversion of fuel to heat energy which heats the air flowing through the chamber. In the process of moving air flow through chamber provides for the creation of a mixture of fuel and air. The purpose of gas turbine is transformed the energy of hot gases into mechanical work. The purpose of the output system is a drain hot gases from engine in the axial direction, converting the thermal and gas pressure energy into kinetic energy which creates thrust and it regulate the work of the gas turbine.

Operational damage of jet engine can occur in flight, on the ground but also during the testing engine. Among the most damaged parts of the engine is the input system and compressor due to aspirating foreign objects into the engine and for burning material - combustion chamber and gas turbine.

3 METHOD FOR CREATING A PROTECTIVE COATING

In currently we knew a large number of technologies for generating coatings which differ in their properties and thickness. Type protection of materials and production technology is selected according to the requirements of the product that we want to treat. Coatings can be chemically divided into inorganic and organic. Among the inorganic metal coatings can include coatings which are produced by thermal spraying. This method will be described more detail in next section.

3.1 Thermal spraying

Thermal spraying include to inorganic metallic protective coatings. It is a new challenging and complex technology which are due to their special properties often used. Thermal spraying can be classified according to the type of power source. For all methods is the same principle of creating protective coatings. On the properly prepared surfaces apply filler material that falls on the relatively cold surface of the product. Then there is a deformation particle of filler material and the formation of protective coating. Resulting protective coating has a layered structure that is formed by applying successive particles of additive material on the surface of the product itself or on the coating.

The process of thermal spraying can be divided into four phases in the following order:

- I. Phase: input material into source of energy,
- II. Phase: the formation of particles material from the original form filler material,
- III. Phase: move particles from the moment of their formation until to their fall on the prepared surface of the pad,
- IV. Phase: cooling the applied coating and the pad.

In the process of protective coatings by thermal spraying method will transform the energy to fuse filler material and its transfer to the pretreated surface of the pad. When selecting appropriate energy used for melting filler material are some important characteristic values and properties that distinguish different energy. These are especially about the maximum power density per unit area and maximum temperature energy sources.

3.2 Thermal plasma spraying

Technology of production of protective coatings sprayed by thermal plasma formed on the basis of quality improvement and development of missile and aviation industry. The use of plasma in the manufacture of protective coatings is characterized by a high energy density and high temperature plasma jet. In the thermal plasma spraying technology mainly use additional material in powder form, which are added into the flow of highly concentrated plasma with high temperature. Output speed plasma jet from the burner reaches high values, therefore particles of powdered filler material, which are entering into the plasma jet is awarded high energy. Therefore there is no need during thermal plasma spray uses compressed air to accelerate the particles of additive material.

When using thermal plasma spraying method are achieved superior properties such as technology of thermal flame spraying or by electric arc. High temperature plasma jet allows create films of different materials independently of the melting temperature. Most are used powders based on cobalt Co, which form hard coatings resistant to abrasion and corrosion. Restriction occurs only in terms of oxidative nature with the liquid stabilization of plasma jet, where a metallic material at elevated oxidation occurs. Therefore can be applied only materials with the highest oxidation number. Thermal plasma spraying require difficult and complex technical equipment, specially adapted workplace or special spray booth, because the premises for the production of protective coatings act harmful factors for human body as light and ultraviolet radiation and high sound level**.**

3.3 Equipment for making protective coatings

In the manufacture of protective coatings thermal spraying need to ensure adequate working facilities for ready and manufacture of high quality coatings.

Equipment for making protective coatings can be divided into:

- **Equipment for surface preparation** (In the method of thermal spraying is necessary to clean and degrease the surface, which will coat. Surface of the material is necessary to get rid of rust and other mechanical impurities as well as fats and oils. Currently, the most common surface material prepared for spraying mechanically by blasting. Blasting is done in chambers designed for blasting with different size, which is measured by the internal volume blasting chamber (Figure 3).).

Figure 3 Blasting equipment

- **Equipment for own spraying** (The power source is a device for checking the parameters, their monitoring, management and electronic control. Feeding equipment filler material- we can use various types of conveying equipment with respect to the number of filler material in powder form for two types of filler materials, for four types of filler materials and for one kind of filler material. Then you analyze plasma torches (Figure 4). Because of the nature of work plasma spraying may vary, there are many kinds of special plasma torches. Plasma torches are divided into torches hand and machine torches, each with different kinds of attachments.).

Figure 4 Plasma torches

- **Peripherals** (Between peripherals advice precipitator dust, water cooler, anechoic chamber, vacuum chamber and robots or manipulators. Although their work is not directly associated with the creation of coatings, perform important tasks. When they are not running correctly affected the entire production process and protective coatings are of poor quality. One of the peripherals is robot (Figure 5).).

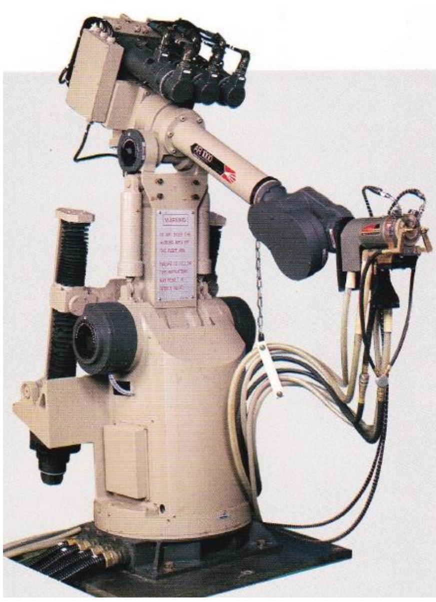

Figure 5 Robot METCO

4 ADDITIONAL MATERIALS

For the production of protective coatings is important to choose appropriate technology but also additional material that we used in creating a protective coating. To create a quality protective coating, it is necessary to work with a quality filler material. Nowadays there are many manufacturers who offer the market a lot of high quality materials for a variety of purposes, such as protection against abrasion, corrosion, increased hardness and the like. Because each material has different chemical and structural properties, it is preferable to combine materials, so we created a more complex mixture of materials more expensive, but with better quality, which is important for consumers.

Additional materials are divided according to their form:

- **Additional materials in the form of powder** (In currently, it is possible to produce any additional materials in powder form, hence their use in thermal spraying technology very effectively. When using powder filler materials in a given technology is important size and shape of the particles.).
- **Additional materials in the form of a wire** (The wire itself can not produce all materials, therefore neither additional materials for thermal spraying in the form of wire, we can produce all materials. As an example, ceramics and special additional materials as NiCrSiB, NiCrAlTaY and more.).
- **Additional materials with a special form**.

From the chemical point of view, we can divide the additional materials:

- **Additional material on a metal base** (These additional materials we include metal alloys. They are more effective than additional materials pure metals and as an example we can mention NiCr and NiAl for good binding properties between the surface of product and the coating. Many of these materials we use during thermal coating in the intermediate layer, which has a positive impact on the coupling of original material and a top coating (ceramics).).
- **Additional material on a ceramic base** (Additional material on a ceramic base have a high resistance to abrasion. They can be divided into oxide (example: Al2O3, Cr2O3), nonoxide ceramic materials and compounds such as carbides, nitrides, and the like. Coating of oxide ceramics creates thermal plasma spraying, because plasma reaches temperatures up to 20000°C and particle velocity of 450ms^{-1}. Such coatings create the surface of the treated product good anticorrosion and antiwear properties.).
- **Additional materials with exothermic effect**.
- **Additional materials based on plastics**.
- **Special additional materials**.

Addition to the above filler materials distinctions are additional materials based on pure metals, such as for example molybdenum, aluminum, nickel, copper and chromium.

For a given problem "increases the life" of the jet engine is advisable to use protective coatings based on pure metals, metal alloys and protective coatings on ceramic base.

5 MODIFICATIONS TO THE ENGINE MPM-20

In the previous section we describe in detail what technologies and materials should be used in making protective coatings. From this analysis, we found that the most appropriate way for our case- increase the life of the engine MPM-20 by making protective coatings, is to create a protective coating by thermal plasma spraying. Before spraying is necessary to modify the surface by suitable methods. The surface must be cleaned of dirt, rust, and grease. Similarly, it must be mechanically adjusted by means of blasting in special chambers for blasting, the value Ra should be equal to Ra = 5-6μm.

After the final surface preparation for coating itself followed its own phase- thermal plasma spraying. After a thorough dismantling of materials, we chose the ones that appeared to be suitable for thermal plasma spraying with the desired conditions for engine MPM-20. We focused mainly on their thermal properties and other properties such as corrosion protection, abrasion, wear leveling dilation and under. Materials that we appeared to be appropriate can be seen in **Annex A**. The following table (Figure 6) is briefly shown draft materials used in individual components of a small turbojet engine MPM-20.

Construction parts of engine MPM-20	Interlayer	Top coating
Input system	-	-
Radial compressor	-	NiCrBSi; NiCrAl
Combustion chamber	NiCr CoCrAlY	$ZrO_2 + Y_2O_3$ $ZrO_2 + Y_2O_3$
Surface of the combustion chamber	-	Al
Gas turbine (stator)	CoCrAlY NiCrAlY	$ZrO_2 + Y_2O_3$ $ZrO_2 + Y_2O_3$
Gas turbine (rotor), Output system	CoCrAlY NiCrAlY	$ZrO_2 + Y_2O_3$ $Al_2O_3 + TiO_2$
Output nozzle	NiCr NiAl	$Al_2O_3 + TiO_2$ $ZrO_2 + Y_2O_3$

Figure 6 Overview of the protective coating Annex A

Interlayer used for balancing dilation between the hot parts of the engine and top coat, it is not necessary to use it in the compressor, because there are still relatively low temperature and the surface of the combustion chamber is used only aluminum Al, which serves as a protection against corrosion for searing high temperatures and for calming material. Interlayer are equally good binding properties.

6 CONCLUSION

The task of my thesis was to design appropriate technology creating protective coatings, chooses appropriate materials for additional protection materials hot parts of the MPM-20 and subsequently applied to the selection of a small jet engine MPM-20 to increase engine life, most especially bearing hot parts. At the beginning I work closely analyzed the MPM-20 for familiarization with the problem, which component parts is needed coating. After studying the detailed engine I have dealt with the appropriate choice of technology and materials. How best method of coating is seem method of thermal plasma spraying, which is described in more detail with it the appropriate materials. As I have suggested intermediate materials based on metal alloys, because coping dilation and prevent corrosion. As a topcoat I propose oxide ceramics due to the high melting temperatures, which would increase the working time engine.

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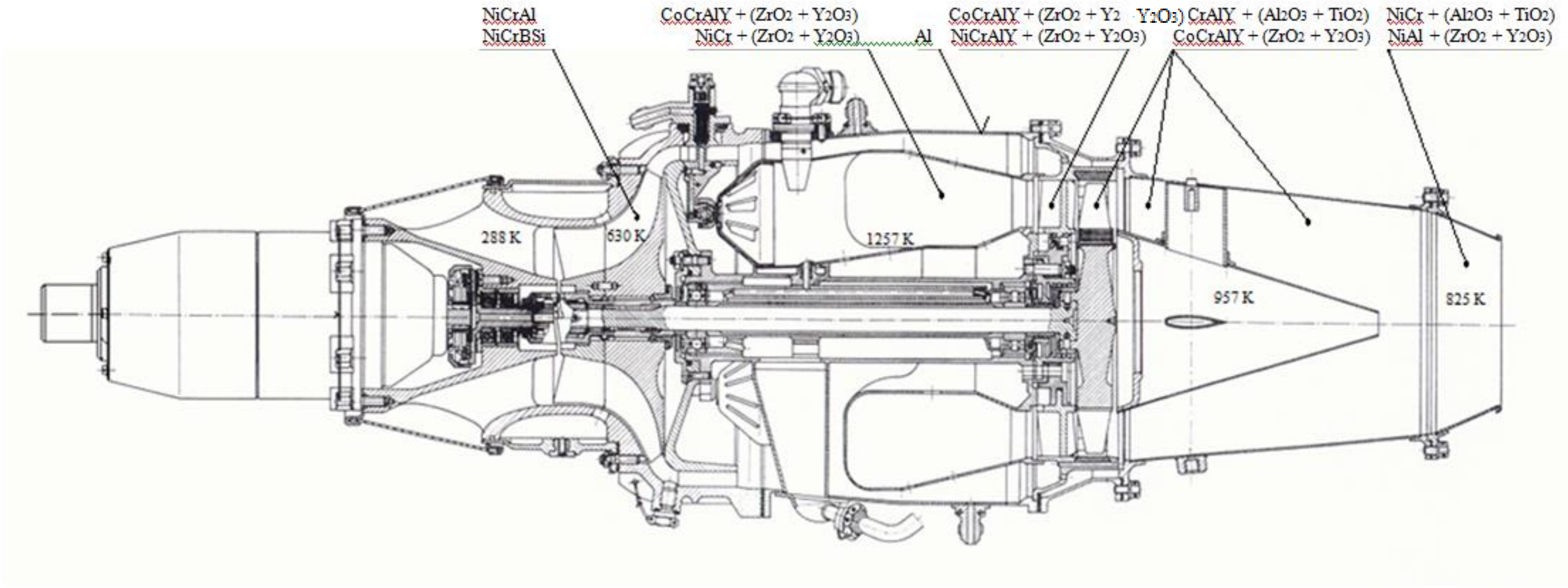
AUTHORS´ ADDRESSES

Cúttová Miroslava, Bc.
Technical University of Kosice, Faculty of Aeronautics
cuttova.miroslava@gmail.com

doc. Ing. Peter Mrva, CSc.
Technical University of Kosice, Faculty of Aeronautics
peter.mrva@tuke.sk

Draft Amendment MPM-20 by using Coatings

Annex A:



Bc. Miroslava CÚTTOVÁ