EXPERIMENTAL RESEARCH ON THE METALLIC MATERIAL DEFECTS APPEARED AT THE OPERATION OF PUMPING AGGREGATES

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Within the companies with specific of land improvements, water supply, a large volume of problems for exploitation, maintenance-repair, with large economic effects, results from the use of the components of the aggregates and pumping installations. These are a direct consequence of the related technologies, technological flows, operating conditions and environment. Parts and subassemblies can come out of operation - with the machine switched off - due to wear, overloading, aging, mismanagement, etc. Friction is a process of molecular, mechanical and energetic nature, between contact surfaces in relative motion.

In this paper the authors present the results of visual investigations on the defects that appeared during the operation of some cast iron and steel parts that make up pumping aggregates. Also presented are the researches carried out by optical microscopy on some representative samples taken from castings and steel that make up

Keywords: pumping aggregates, cast iron, steel, defects, structural investigations, optical microscopy

1. Introduction

For the proper functioning of the pumping units, at the same time as maintaining the level of expenses for this purpose and in parallel with a rational operation, possibilities of improving the maintenance and repair activity must be found.

The transmission of the force flow between the elements of the friction joint is made by the friction surface, characterized mainly by microgeometry (dimensional, distribution law, roughness, etc.) [1].

The process of friction - wears conditions and is conditioned by the friction surface. The existence in it of several layers or contact areas is due to the

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intensity and duration of the friction process, the contact materials, the thermal aspects, and the environment.

Under the action of the load the asperities deform elastic, plastic, elastic-plastic, plastic with crunching, according to the force values, the degree of precision of the processing of the surfaces and of material [2, 3].

Physical wear of components that cause gradual loss of operating properties can be dynamic or static - regardless of whether the aggregate works.

Dynamic physical wear occurs during the actual operation of the aggregates and is accompanied by the transfer of a portion of their value over the conjugated landmarks. Its appearance leads to the worsening of the technical and economic conditions of operating the machines. Operating the aggregates over a certain wear limit becomes uneconomical and even dangerous.

Static physical wear is observed in all aggregates and is accompanied by fatigue or aging of the materials [4[.

In general, defects in pumping units can occur in two distinct forms, due to visible and measurable wear (the higher the risk of damage increases); in many cases in this situation it is possible and useful to prevent the replacement of worn parts or due to an accidental and unforeseeable failure; in this case it is not possible to intervene preventively.

2. Experimental

The investigation of the defects that appeared during the operation of the pumping units, mainly aims to identify the causes that led to the wear of parts and subassemblies and implicitly to the stopping of the machine.

The main benchmarks and subassemblies of a pumping unit, subject to investigation in order to determine as precisely the causes of the wear are:

- at the level of the bearings of the aggregate: the wear bushings, the rubber bearings, the bearings having a wear area other than rubber, such as YSn83, the bearings of the bearings;
- at the level of the elements that concretely pump the liquids: the rotor chamber (cylindrical or spherical - in the variant of the spherical one, at the wear rings that give the architecture of this type of rotor chamber); rotors (at blades level in the case of open rotors).

Take the stator level (a type of wear for the bore in which a bearing holder is mounted, and another type of wear corresponding to the pipes that direct the liquid to the discharge area); at the level of the suction funnels, etc.

- at the level of the casings and pipes, depending on the specificity of the pump, - at the level of the connection and coupling elements between the pump itself and the electric drive motor.

The investigation of the defects is also done visually by optical microscopy [5,6].

3. Results and discussions

Visual investigation of the defects of the component parts of the pumping units

The visual investigation is carried out by measurement (with the micrometer, the chisel, the comparator, etc.) and the dimensions are observed within the tolerances provided by the designer, for a normal operation.

In Fig.s. 1-4 are presented some benchmarks of the pumping units which are visually observed different types of wear.

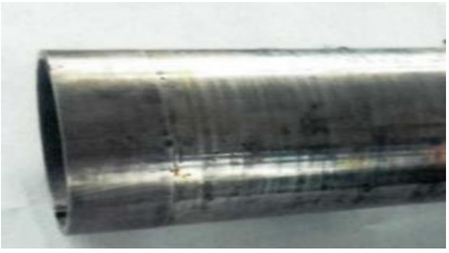


Fig..1 Adhesion wear - exfoliated mouth

Fig..2- Brateş pump wear bush, corroded

Fig..3 Pump rotors with broken blades

Fig..4 Disc discharge pump with surface wear

Investigation by optical microscopy of the metal parts that enter the component of the pumping units

The experimental researches were carried out for five experimental samples, obtained by cutting and cutting from the pump wear tube DV 2-87, the wear pump bucket Brates 400, the suction pump MIL, the hub rotor pump MIL and the rotor pump MIL.

These experimental samples are presented in Fig.s. 5-9.

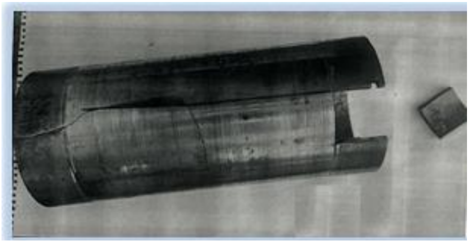


Fig. 5 Sample 1. Pump bushing wear DV 2-87

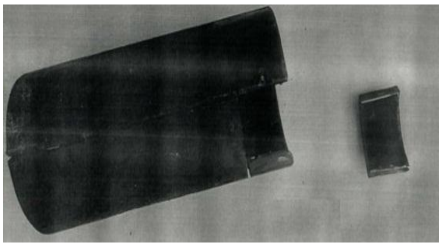


Fig. 6 Sample 2. Pump bushing wear Brates 400

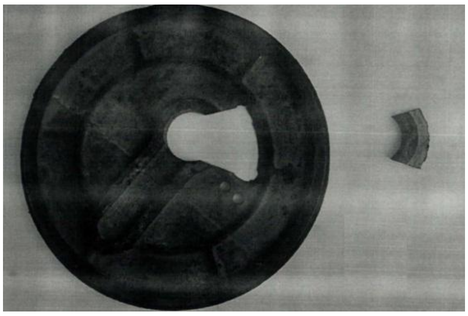


Fig. 7 Sample 3. Suction pump suction disc MIL

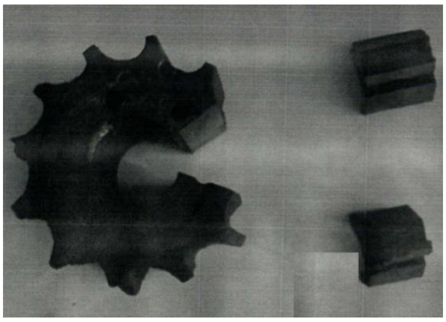


Fig. 8 Sample 4. Pump rotor blade MIL

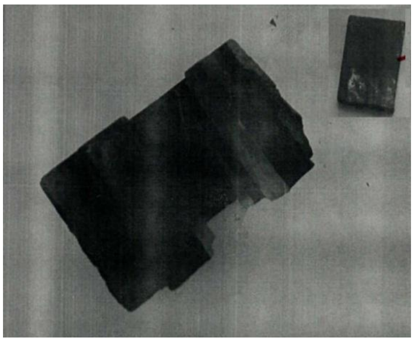


Fig. 9 Sample 5. Pump rotor blade MIL

From the samples cut from the samples -, samples were prepared for investigation of composition and quantitative optical microscopy in the Laboratory for the preparation of samples for microstructural investigations at the CEMS Research Center in UPB.

The laboratory is equipped with equipment for the mechanical polishing of samples, Bollmann equipment for polishing and / or electrolytic welding, equipment for preparing the samples necessary for transmission electron microscopy investigations and equipment for preparing at low temperatures the samples required for transmission electron microscopy investigations [7].

The determination of the chemical compositions of the cast iron and steel samples was done in the laboratories of the CEMS and ECOMET research centers of the POLITEHNICA University in Bucharest by the X-ray diffraction and fluorescence method.

The compositions of the investigated samples are presented in the table 1.

Tabel 1

Chemical compositions in mass percentages of the investigated samples

Spl.	Material	C %	Mn %	Si %	P %	S%	Cr %	Mo%	Ni%	Fe %
1	steel	0,24	0,79	0,52	0,015	0,031	11,15	0,009	0,257	balance
2	steel	0,17	1,04	0,21	0,022	0,015			0,072	balance
3	Cast iron	4,40	0,57	1,85	0,07	0,04	0,102	0,023	0,045	balance
4	Cast iron	4,97	0,54	1,74	0,039	0,043	0,129	0,021	0,09	balance
5	Cast iron	5,16	0,59	1,71	0,023	0,029	0,157	0,029	0,044	balance

Investigation by optical microscopy of the metal parts that enter the component of the pumping units is done to determine if the structure of the material from which the landmark was initially manufactured, has been modified by the presence of external disturbing factors (high uncontrolled thermal regime, vibrations, strong shocks, etc.).

The determinations by optical, quantitative and qualitative microscopy were made at the POLITEHNICA University of Bucharest, Department of Metallic Materials Science, Physical Metallurgy, within the Laboratory of Quantitative Analysis.

The laboratory equipment includes a REICHERT UnivaR optical microscope and an Epityp metallographic microscope (Carl Zeiss Jena). The REICHERT UnivaR optical microscope has a video camera with adapter, image acquisition interface, computer and printer [8, 9].

Investigating the structure of the samples after chemical attack

The results of the investigation of the structure of the samples after the chemical attack are presented in the Fig.ures at four successive stages of enlargement.

All the samples were prepared, subjected to the chemical attack with Nital 2%, the images of the metallographic structures realized at successive magnification degrees (100: 1), (200: 1), (500: 1) and respectively (800: 1), (standard unit of measurement representing 100,70,20,10 µm) are presented in the Fig.s. 10-14.

Fig.. 10-Sample 1

The observed structure is composed of fine martensite of recurrence with traces of residual austenite.

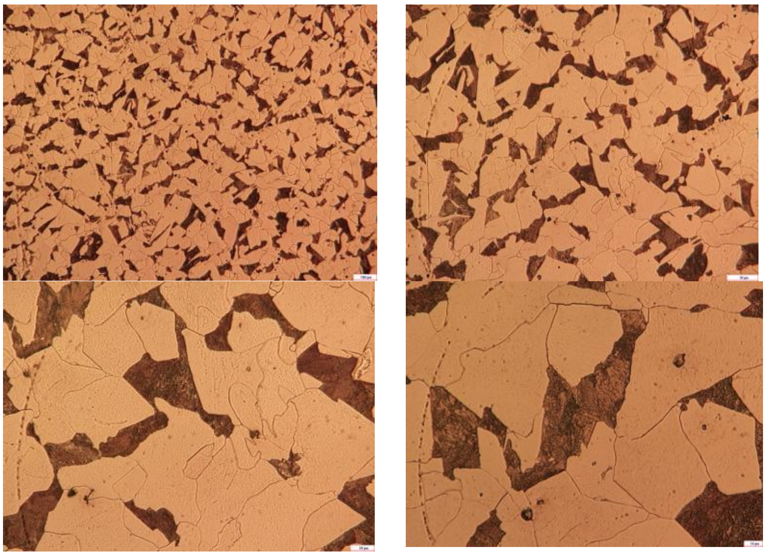


Fig.. 11-Sample 2

The structure of the material is a structure of equilibrium, relatively uniform and composed of ferrite grains and degenerate (ally) perlite grains.

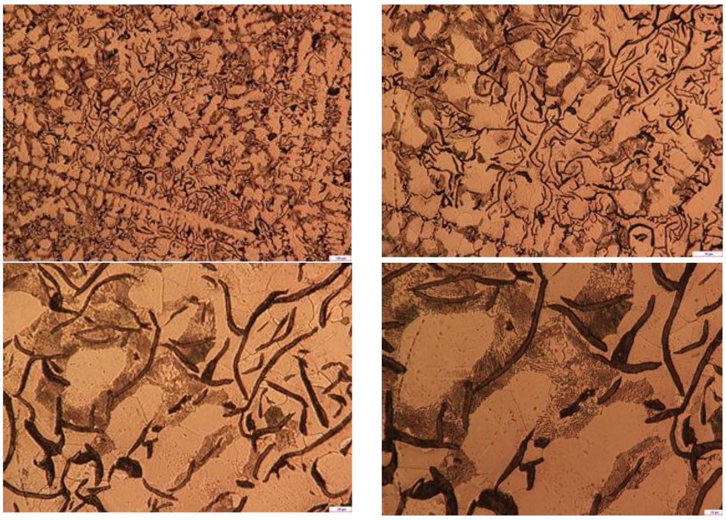


Fig.. 12-Sample 3

The micrographs of Fig.. 3 show a gray cast iron structure with lamellar graphite and a ferrite-pearlite base mass.

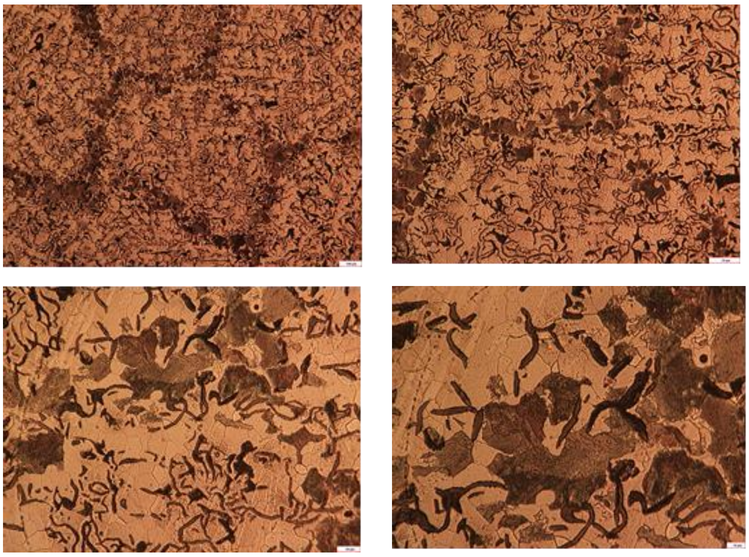


Fig. 13-Sample 4

The observed structure is of gray cast iron with slightly modified graphite (vermicular), with ferrite-perlite base mass.

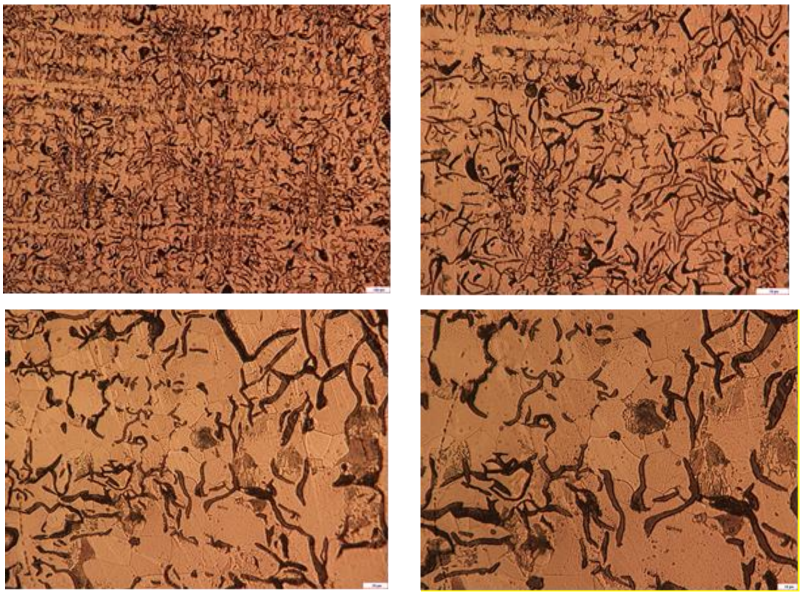
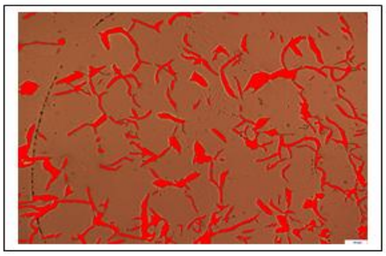


Fig. 14-Sample 5

The observed structure is of gray cast iron with slightly modified graphite (vermicular), with ferritic base mass.

For the cast iron samples, a graphite proportion was determined. The results are presented in Figs. 15-17.

The captured image



The processed image

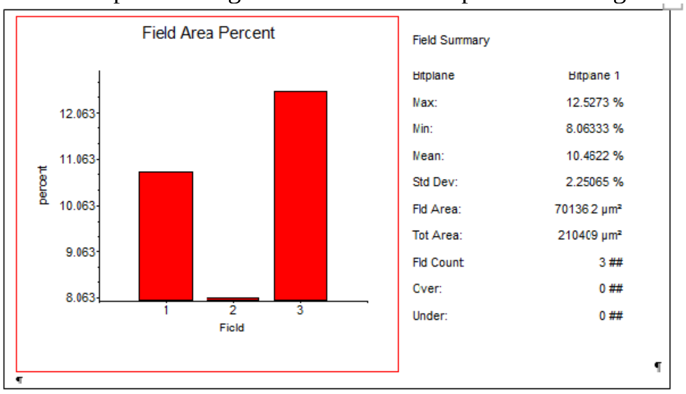
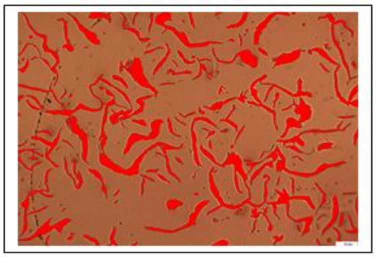


Fig. 15-Graphite sample ratio 3, calibration 0.19113 µm / Pixel

The quantitative analysis of graphite was performed on three fields, in order to be able both its proportion and its distribution in the basic mass. Thus, from Fig. 15 it is found that graphite is relatively evenly distributed between 8% and 12.5% with an average of 10.5%.

The captured image



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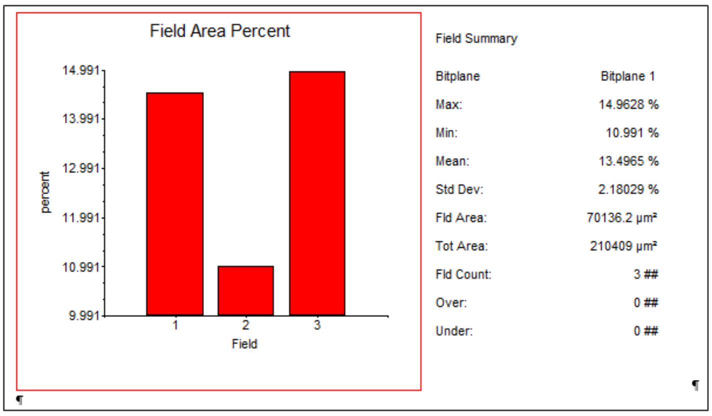
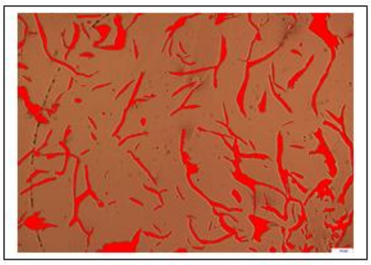


Fig. 16-Graphite sample ratio 4, calibration 0.19113 µm / Pixel

As in the case of the previous sample, the quantitative analysis of graphite was performed on three fields, in order to be able both its proportion and its distribution in the base mass. Thus, from Fig.. 16 graphite is found to be relatively evenly distributed between 11% and 15% with an average of 13.5%.

The captured image



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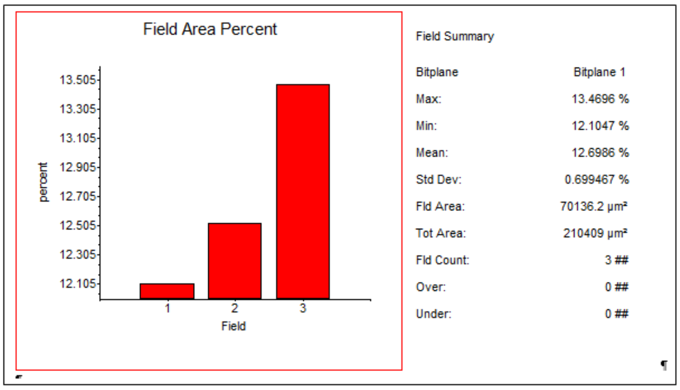
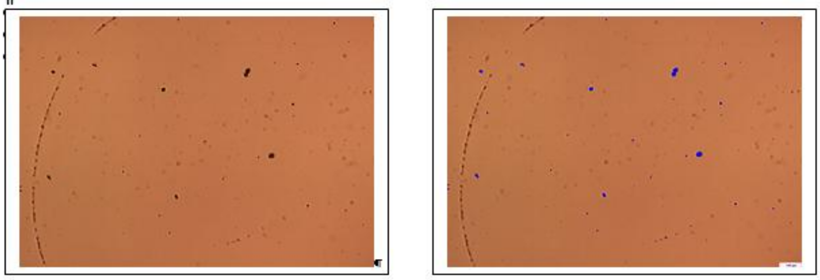


Fig. 17-Proportion graphite sample 5 calibration 0.19113 µm / Pixel

From Fig.. 17 it is found that in sample 5, graphite is also relatively evenly distributed, with a ratio between 12% and 13.5% at an average of 12.7%.
For the steel samples, the proportion of non-metallic inclusions was made. The results are presented in Fig.s. 18-19.



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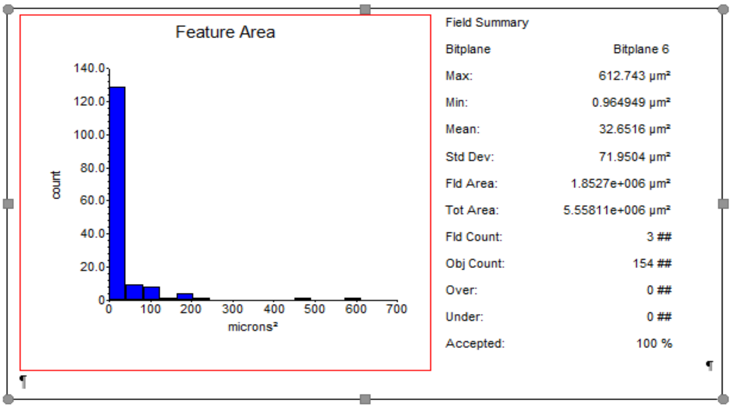
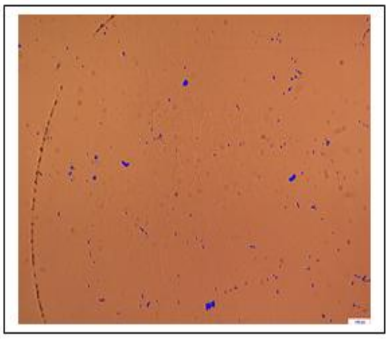


Fig.. 18-Inclusion Sample 1, calibration 0.98232 µm / Pixel

Given the importance of the shape, size, orientation and distribution of the inclusions present in the structure of a metallic material, quantitative determinations were made on the inclusions in samples 1 and 2.

For the best accuracy of the results, the analyses were performed on a number of 3 fields. The analyses aimed to classify the inclusions into a number of 10 size classes in terms of their size. In case of sample 1, the relatively fine inclusions, mainly oxides, fall within the limits of 0.9 µm^2 and 600 µm^2 with a weighted average of 30 µm^2.

The captured image



The processed image

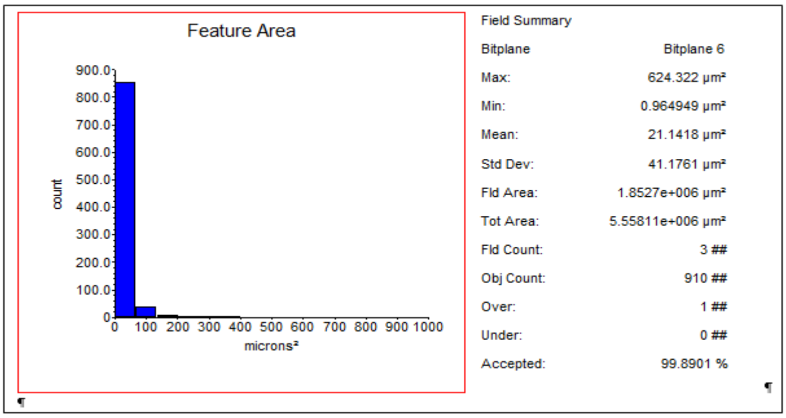


Fig. 19-Inclusion of sample 2, calibration 0.98232 µm / Pixel

As in the case of sample 1, in the case of sample 2 the inclusions are relatively fine, mainly oxides and fall within the limits of 0.9 µm^2 and 600 µm^2 with a weighted average, slightly lower than 20 µm^2.

4. Conclusions

The metal parts investigated show physical surface wear (exfoliation of the bushes, corrosion of the discharge discs), as well as breakages of the rotor blades as a result of chemical but also physical actions (water with harsh impurities).

Analyzing the chemical composition of castings and steel it is found that they were suitable for the uses that these pieces had. Analyzing by optical microscopy samples taken from these parts can be said to have retained their initial structure even after a long service life, the structure corresponding to both steel parts (including the number and distribution of inclusions) as well as those of cast iron have a proper proportion and distribution of carbon in the form of graphite in the base mass.

The chemical compositions and the corresponding structures were those that determined a normal duration of use of the metallic parts that enter the component of the pumping units, the deterioration and their decommissioning are motivated by physical, partially chemical, static and dynamic uses surface of the parts that are in contact with the pumped agent.

The remediation of the surface wear caused can be done by making the parts of a pump made of metallic materials that will accept the reconditioning by applying successive layers of metal and that after the machining by cutting will return to the original dimensions of the project [6, 10].

Acknowledgment

All authors contributed equally to the development of the experimental research and was done as a result of participating of Cristian Pandelescu in the SIMBA Program

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