ANALELE UNIVERSITĂȚII
"EFTIMIE MURGU" REȘIȚA
ANUL XVII, NR. 1, 2010, ISSN 1453 - 7397

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Rehabilitation of Plant Units at Pumping Stations

During operation process, industrial pumps are subjected to wear and corrosion that often lead to various physical damages and functional faults. Although this is not a habitual case, when occurs, it is very expensive to replace the affected parts with new ones and in most of situations this isn't the best problem solving. A way to deal with this type of problem at pumping stations is rehabilitation of plant units. The present paper describes a solution to rehabilitate worn pumps using CERAMITECH treatments based on epoxy resin and polyamine - amides reinforced with carbide and ceramic particles. Also it shows measurements before and after using the treatment.

Keywords: *pump, treatment, characteristic curve, CERAMITECH.*

1. Introduction

Reinsertion of physical and moral worn pumps in the industrial circuit, with minimum investment in their restoring, preferably by self efforts if possible, is a better solution than using them as a metal waste. Reconditioning and modernization of pumps by the manufacturer, by field dedicated companies, ensured the continuing extension of their exploitation with high yields but as well as high costs [2].

There are taken into consideration type NDS 18 and type NDS 12 of pumps, manufactured and widely used on water supplies, draining, irrigations, etc.

It is aimed at pump reconditioning in the inherent workshops and at their reinsertion in the internal industrial circuit, the incomes from using them as metal waste being insignificant.

Improvements of pump performances can be accomplished by:

a) Operating with clearance at nominal values (sliding or roller bearings);

b) Replacing pump's impeller;

c) Inside planking of pump's housing using CERAMITECH in order to reduce asperities and friction coefficient [4];

By applying these treatments it is estimated a pump station yield increase of 14 to 22 percent.

Rehabilitation and re - commissioning of type 12 NDS and type 18 NDS pumps in autochthonous industry is suitable due to large number of operating pumps, the origin of internal production and to high replacement costs with new equipments, mainly imported.

An important aspect for this case is using the existing constructions, not being required to replace the pipes. Withal it is not necessary to replace the adaptor and the electric equipment. The existing emplacements don't require structural modifications.

2. Optimizing assumptions of maintenance endurance in pumps exploitation

For an accurate approach to the problem a few assumptions must be taken into account:

a) From economical and functional reasons, most of times the hydraulic circuit of each pump from the station presents no straight pipe long enough to accurately measure the updated flow, Q_{pa}, through that pump.

b) In any pumping station it can easily be measured, periodically or continuous, for every pump, the updated value, H_a, of pumping height, H, and at electric motor driven pumps it can be measured the updated value, P_{ba}, of terminal capacity, P_b.

c) In exploitation, the operating characteristic curves of electric motors that drive the pumps, including shaft capacity curve P_a – terminal capacity P_b, don't show significant changes if the motors aren't rewound. In case of changes in operating characteristic curves after rewinding, their updated plotting is possible by in situ measurements.

d) The updated operating characteristic curves Q_a – H_a and Q_a – η_a for each operating pump can't be plotted by in situ measurements but the updated operating characteristic curve shaft capacity – pumping height, P_{aa} –H_a, curve not used so far by the field specialists, can be plotted at any time

e) While exploiting a pump changes appear at its operating characteristic curves, Q – H, Q – η, H – η, P_a – η and P_a – H, caused by physical wear and impairments due to functional clearance, with particularities for each pump typo-dimension [1].

f) Modifications of operating characteristic curves being caused by physical wear and impairments due to functional clearance, with a proportional dependence, and also being particular to each pump typo-dimension, it is explainable the existence of a correlation between curve changes, definable using measurements on pump tests stand.

g) For every pump typo-dimension, after obtaining the operating characteristic curves, for pump tests stand, for the complete operating domain, for a new pump, as well as for pumps that have been operating in pumping station different periods of time and have varying degrees of physical wear, the specific correlation between curves modifications will be determined.

h) For every operating pump in pumping station, knowing the incipient operating characteristic curves, as well as the specific correlation between the modification of the curves due to wear, at any time can be obtained, by measuring, the updated curve $P_a - H_a$ and can be inferred the updated operating characteristic curves $Q_a - \eta_a$ and $Q_a - H_a$ [1].

i) For a more precise defining of updated pump operating characteristic curves, the influence of asynchronous electric motor sliding curve, $s = f(P_a)$, will be taken into consideration. Slighting of this influence can lead to obtaining over 10 percent errors.

For every typo-dimension of new pumps or pumps that have been operating various periods of, with different degrees of wear, after obtaining operating characteristic curves and determining the correlation between their modifications, values for yield can be inferred. By technical – economical calculus it can be stated whether the pump must be replaced, rehabilitated or modernised [2].

3. Examples of operating curves modifications at type 12 NDS and type 18 NDS pumps

Pumps of type 18NDS and type 12NDS from "Uzinele de Produse Sodice Ocna-Mures" (UPSOM) are taken into consideration, which have been modernized at AVERSA after many years of exploitation.

The yield average spread between the worn pump and the modernized pump is near 15% for type 18NDS, 22% for first pump (I) type 12NDS and 14% for second pump (II) type 12NDS. The modernized pumps were tested on test stands of S.C. AVERSA before as well as after modernization in order to obtain operating characteristic curves.

Tables 1 to 6 show values of flow (Q), pumping height (H), yields (η) and shaft capacities (P_a) for pumps 18NDS and 12NDS determined before and after modernization [3].

Table1. Operating characteristics - worn 18NDS pump (980rpm)

	1	2	3	4	5	6
Q(m^3/h)	3050,8	2822,4	2718,6	2454,0	2012,8	1507,3
H(m)	24,3	44,9	48,4	53,4	58,1	61,8
η (%)	41,1	71,9	75,6	78,3	76,1	69,2
P_a (kW)	491,5	480,9	473,9	456,8	418,5	366,3

Table2. Operating characteristics - modernized 18NDS pump (980rpm)

	1	2	3	4	5	6
Q(m^3/h)	2978,1	2875,3	2409,0	1971,6	1516,4	1046,4

H(m)	33,4	38,0	51,1	58,5	64,3	67
η (%)	72,1	79,8	91,3	89,8	84,9	72,4
P_a (kW)	375,6	373,4	359,3	350,1	313,1	264,2

Table3. Operating characteristics - worn 12NDS pump I (1480 rpm)

	1	2	3	4	5	6
Q(m^3/h)	973,6	868,8	789,9	594,7	508,5	204
H(m)	44,8	48,2	50,4	54,8	56,5	58,6
η (%)	64,3	64,5	64,5	59,5	56,1	30,0
P_a (kW)	184,3	176,7	168,2	149,3	139,9	108,7

Table4. Operating characteristics - modernized 12NDS pump I (1480 rpm)

	1	2	3	4	5	6
Q(m^3/h)	1287,3	1210,4	1107,2	950,7	796,9	529,7
H(m)	31,7	36,0	40,5	46,2	51,5	58,7
η (%)	75,1	81,1	84,9	87,4	87,6	79,2
P_a (kW)	148,1	146,4	143,8	137	127,6	104,2

Table5. Operating characteristics - worn 12NDS pump II (1480 rpm)

	1	2	3	4	5	6
Q(m^3/h)	1403,7	1233,4	1155,5	1045,4	883,1	691,8
H(m)	23,3	33,3	37,7	41,7	47,0	52,3
η (%)	47,2	61,6	66,5	69,2	71,4	69,7
P_a (kW)	188,8	182,0	178,6	171,8	158,3	141,4

Table6. Operating characteristics - modernized 12NDS pump II (1480 rpm)

	1	2	3	4	5	6
Q(m^3/h)	1365,6	1189,5	904,0	660,0	502,0	261,5
H(m)	28,3	37,5	48,2	55,1	59,3	62,0
η (%)	65,2	79,0	85,4	80,3	73,7	47,8
P_a (kW)	161,7	154,0	139,2	123,5	110,0	93,3

4. CERAMITECH HG

It is a chemical product based on epoxy resin and polyamine - amides reinforced with carbide and ceramic particles. It is used for overlaying surfaces with high adhesion. It can be used for reconstructing the inside bodies of pumps. It has a high mechanical resistance as well as resistance to abrasion and erosion. It is easily applied in a single layer or successive layers by spraying or brushing, considerably improving the friction coefficient. It was tested in the materials testing laboratories from Pegnitz, Germany [4].

Depending on the nature of pumped liquid there is a mechanical or thermal impact with corrosive and abrasive effects upon the surfaces that come in direct contact with the pumping liquid

The parts for the water pump are made out of pig iron and low-alloy steel. Because of limited endurance of these materials and of inimical working environment with a high content of dust, plants components degrade rapidly. Manufacturing of stainless steel parts presumes high expenses. Components treatment using CERAMITECH HG is an alternative solution to improve efficiency in pumping stations.

In figures 1 to 3 (electronic microscope scanning) are shown the surfaces of a treated component [1].

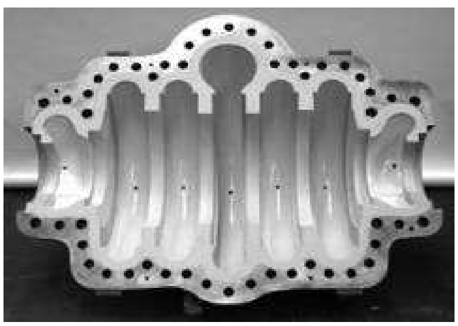

Figure1. The upper pump side treated with CERAMITECH HG [5]

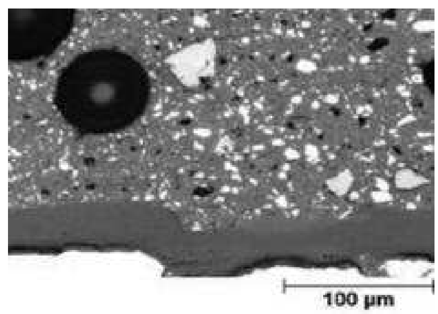

Figure2. Cross section of material Thortex Cerami Tech FG [5]

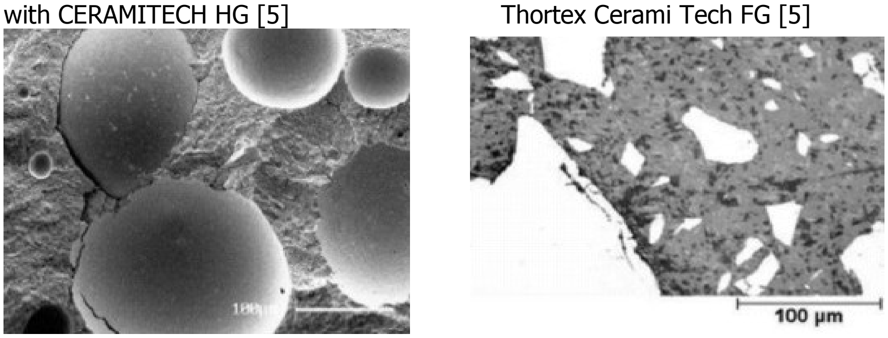

Figure3. Microphotographs of material section [5]

Most of the tested overlays are a class of epoxy resins (Cerami Tech HTX, ARC MX 2, CeramKote 54 HY, VK2000TF, RH 1867, etc). For increasing their resistance to wear these are mixed with solid particles as alumina, silicone carbide, etc. The hardener (hardening accelerator) is mixed with epoxy resin before being used. After overlay it hardens at room temperature [4].

5. Conclusion

In case of treating using layers thick enough (3mm) and applying with a spatula there have been noticed a high resistance to wear. Overlaid surfaces must be easily accessed in order to be properly prepared for coating application. Otherwise the cover layer will not adhere sufficiently to the metal layer.

Thus, the narrow impeller tubes can't be covered well enough. Great importance must be given to the temperature of pumped agent, accordingly to manufacturer recommendations. A regular checking with repairing of damaged areas is indicated.

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