Considerations Regarding the Use of EPO 99 B Resin in Manufacturing AXIAL Hydraulic Machinery Runners

LIVIU EUGEN ANTON[1]*, ILARE BORDEAªU[1], IULIAN TABÃRÃ[2]
[1] Politehnica University of Timiºoara, 1 Mihai Viteazul Blvd., 300222, Timisoara, Romania
[2] Politehnica University of Bucharest, 313 Splaiul Independentei, 060021, Bucharest, Romania

The epoxy resin EPO 99B, known under the name REZOLIN, is one of the main materials used in manufacturing/modeling the axial runner of hydraulic machines. The simplest device of this kind is the inducer employed to reduce the cavitation intensity of the main pump impeller. The geometry is determined from hydrodynamic conditions, is a very complex one and is subjected to dynamic mechanical stress (vibrations). As a result of those conditions the resin must have good mechanical and technological qualities. It was realized at SC Elba SA Timisoara, and is made from a mixture between the resin H9951 and a fortifier. The obtained inducer runners have been tested in air at the Hydraulic Machinery Laboratory of Timisoara Polytechnic University, and supplementary the basic material was tasted to cavitation erosion resistance. As a result, our work takes into considerations both the impeller hydrodynamic performances and the behaviour of the manufacturing material (resin EPO 99 B) to cavitation erosion.

Key words: epoxy resin, cavitation erosion of plastic material, inducer runner performances

The heavy suction conditions in which operate the pumps, especially in chemical and oil industry determine the use, on a large scale, of inducer runners in order to protect the main impeller by the erosion determined by cavitation.

The inducer runner is a precursory runner to the main one, fig. 1, situated on the same shaft and has the purpose to rise the pressure at the entrance of the main one, reducing in this way the cavitation intensity, which can produce, through erosion, big destructions of the main impeller [4]. Therefore the inducer runner plays the roll of sacrificed component. For this reason, its manufacturing cost must be as small as possible, and it must be replaced fast and easy.

The inducer runner presents itself like a screw because its blades form of wrap spires on the hub figure 1.

The runner hub is realized from allied steel pipe and the vanes are made from resin, their stiffness is increased by steel pipes serving as pressure receptacle.

The epoxy resin EPO 99B blade manufacturing procedure is simple and economic [4]. At the beginning is generated a mixture of two components (for 100% resin H 9951 must be added 40% of hardening material), which after hardening obtain mechanical properties like those of steel.

Knowing that the blade surface is a cylindrical, the following relation can be applied:

$(D \cdot tg\beta_s)/2$ = constant =constant;
where β_s is the seating blade angle [4]

Table 1
CHARACTERISTIC OF EPOXY RESIN EPO 99B

Viscosity of the Resin H 9951 (Pa.s)	22,5 ±7,5
Viscosity of the hardening component (Pa.s)	15,0 ± 5,5
Viscosity of theResin HEPO 99B (Pa.s)	37,5 ±12,5
Density (g/cm^3)	1,30
The necessary time for complete hardening	30 minutes at 80^{0}C
The final hardness (SHORE)	76-80

The helix was traced on the hub and with a pitch of 18^o were introduced steel pipes that serve as armature and drain for the measurement of the pressure.

On this framework is poured the epoxy resin. The blade thickness has been assured by two plexiglas shapes, damped with silicon oil, to avoid the resin gluing. The shape of the plexiglass casings has been obtained at warm, by modeling them on the armatures inserted in the runner hub. After resin hardening, the blade has been finished mechanically and finally coated with a protective dye.

Experimental part

The experimental researches have been concerned with the determination of the pressure field upon the inducer runner and the resistance at the cavitation erosion.

Because of the heavy mechanical stresses to which the runner is subjected, the values of mechanical resistance were measured to bending and compression in the Material Strength Laboratory of Timisoara Polytechnic University. These values are: the mechanical resistance to bending is 122 daN/cm^2 and the mechanical resistance to compression is 1536 daN/ cm^2.

The pressure field has been determined by testing the inducer runner in the air, using a facility specially designed and built for this purpose, (fig. 2) provided with a process computer [5]. The obtained results have been transposed for water, to make possible the comparison with the theoretical results and to analyze the cavitation behavior of the runner.

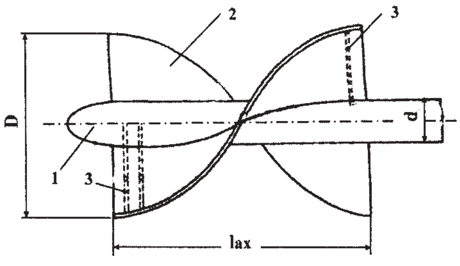

Fig. 1. The geometric shape of inducer runner
1. runner hub; 2. helicoidally blade; 3. steel pipes

* *email: liviu.anton@tiriacauto.ro; .Tel.: 0741333830*

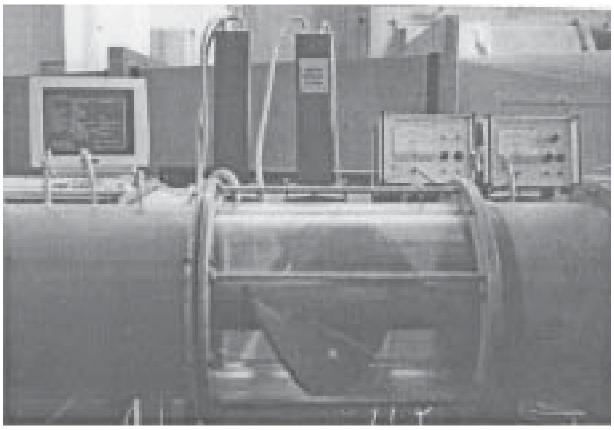

Fig. 2. The test facility

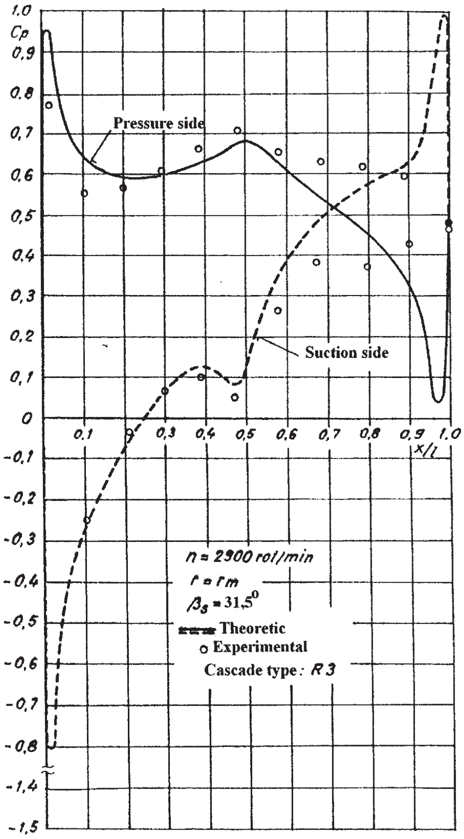

Fig. 3. Comparison between the theoretic and experiemntal coefficients Cp at the hydrofoil border

In figure 3 is presented the comparison between theoretical and experimental pressure coefficients. The theoretical values have been obtained through the finite element method [2] with the hypothesis of potential movement, to the profile frontier and a very good correspondence between the two determinations was found , especially at the first half of profiles.

The good mechanical characteristics as well as the analysis of the sensitivity coefficent for cavity $Kp_{max} = -Cp_{min}$ sugested to authors the possibility to use the resin for hydrodinamic impellers. The way have been taken resin samples tested at the cavitational attack.

The good mechanical characteristics and the cavitation sensibility coefficient $Kp_{max} = - Cp_{min}$ analyze have suggested to the authors the possibility of resin utilization for manufacturing inducer runners for laboratory purposes.

The resin resistance to cavitation erosion was tested separately in the magnetostrictive vibratory test facility, with nickel tube, at the Hydraulic Machinery Laboratory of Timisoara Polytechnic University [1], [3]. The total cavitation duration was 30 min divided in three periods respectively 5, 10 and 15 min. The cavitation erosion resistance of the resin was compared with those of the steel OL 370-3k and is presented in figure 4.

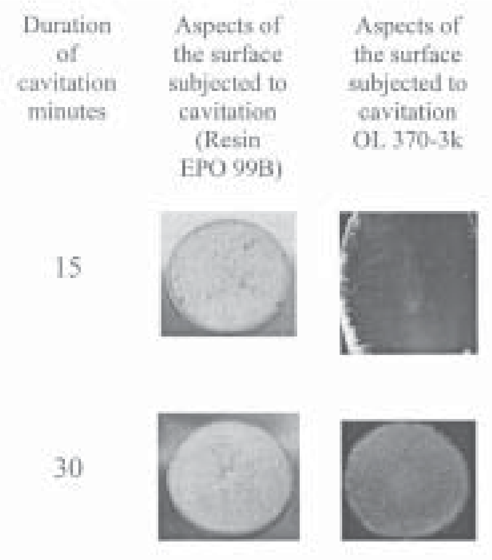

Fig. 4. Aspects of surfaces exposed in cavitation erosion

Results and discussions

As it is shown in figure 3, we can see a good approximation between theoretical and experimental results. The differences that occur at the trailing edge are normal, taking in consideration that in the experiments the flow presents detachments, and the theoretical results were obtained for a potential movement [5].

The examination with the optic microscope of the damaged area (fig. 4), show the weakness of the resin to cavitation, even in comparison with the OL 370-3K steel, considered with very low cavitation erosion resistance. This disadvantage is because of the resin structure type, which cannot resist to shock stresses, realized on small surfaces, specific to hydrodynamic phenomena. The pits observed in various places reflects clearly the weak molecular bounds, which do not resist to the pressure induced by the microjets and shock waves generated during the implosions of cavitation bubbles [1, 3, 6].

Conclusions

The use of resin EPO 99B, as a manufacturing material for inducer runner models, it is adequate, if the performances are tested in air. The advantage of its utilization consists in time economy and the low cost, as a result of the manufacturing procedure and setting. Also, the results transposed from the air to the liquid medium illustrate the approach to reality of the energetic and cavitation characteristics.

The production of inducer runners, from this type of resin, for industrial purposes (with specific conditions for cavitational hydrodynamic) is not indicated because of the weak resistance to the cavitational erosion even if the mechanical characteristics are close to the steel ones

The use of the resin is acceptable only for manufacturing industrial devices working in air (fans, wind turbines etc.).

Acknowledgments: The present work has been supported from the National University Research Council Grant (CNCSIS) PNII, ID 34/ 77.01.2007: . Numerical computations have been performed at the Numerical Simulation and Parallel Computing Laboratory from the

“Politehnica” University of Timisoara, National Center for Engineering of Systems with Complex Fluids.

References

1.BORDEASU I., POPOVICIU M., MITELEA I., GHIBAN B., BALASOIU V., TUCU D.,Rev. Chim. (Bucureºti), **58**, Nr.12, 2007, p. 1300
2.HADAR, A., BORDEASU I., MITELEA I., VLASCEANU D., Mat. Plast., **43**,Nr.1, 2006, p.70
3.MITELEA, I., BORDEASU I., HADAR A., Rev. Chim. (Bucureºti), **56**, Nr.11, 2005, p.1169
4.ANTON, L., E., MILOª, T., -Pompe centrifuge cu impulsor, Editura Orizonturi Universitare, Timiºoara, 1998, ISBN: 973-9400-08-6
5.ANTON, L., E.,Determination of Pressure Distribution on the Blades of Inducer, The XVII-th IAHR Symposium, Beijing, China, 1994
6.POPOVICIU M. O., Consideration Upon the Experimental Estimation of Cavitation Resistance, Sc. Bull of the Politeh. Univ. of Timisoara, Trans on Mech; Tom 49 (63), 2004 p. 265

Manuscript received: 18.04. 2008