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PERFORMANCE CHARACTERISTICS MODIFIED LOW LIFT PUMPS 100-K AREA

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PERFORMANCE CHARACTERISTICS - MODIFIED LOW LIFT PUMPS 100-K AREA

INTRODUCTION

A development program was initiated under Project CG-775 to test the proposed process water pump modifications for Project CGI-883, Increased Process Water flow 100-K Area. Both the high lift and low lift pumps of the 190-KE pumping unit were modified during May, 1959 for in-service prototype testing of the proposed equipment revisions. The testing proved the feasibility of the modification program but a problem, in the form of cavitation damage to the high lift pump impeller, was noted. An incremental production gain at the KE reactor was realized as a result of the test program. Interim funds were authorized in February 1960 to initiate detail design on total KE and KW water plant expansion and to modify one KW process pumping set for an early incremental production gain at the KW reactor. The modified KW process pumping unit was placed in service in mid-1960 and a proportionate reactor production gain was realized. Shortly after the modified KW pumping unit was placed in service it was noted that the total process water flow in KW was somewhat greater than in KE. An investigation was made to evaluate the low lift pumping units in each area to find out if they contributed to the difference in flow. This report describes the results of the investigation.

SUMMARY AND CONCLUSIONS

With the modified low lift pump in each area adjusted for the same impeller clearance and operating at the same speed it was found that the KW unit was pumping with approximately six feet more head. The only difference in the pumps was in the degree of finish of the impellers. The KW impeller had been hand finished to a bright finish whereas the KE impeller was in the as cast or normal commercial finish condition. It was concluded that the special finish of the KW impeller accounted for the additional head. The additional head obtained by impeller polishing, when evaluated with the total process water system characteristics, will provide an additional 500 to 700 gpm flow if all CGI-883 impellers are hand polished. This additional flow is estimated to increase the reactor production capabilities \$125,000 to \$175,000 per year when the production of both areas is considered.

DISCUSSION

Description of Pump Sets

The KE and KW modified process pump sets consist of a low lift vertical turbine pump in series with a high lift centrifugal pump rated at 35,000 gpm at a total head of 1090 ft. The low lift pump in each area is as near identical as manufacturing tolerances and construction practices will allow except that the KW impeller has been hand polished to a bright finish. The high lift impeller in KW area had previously been installed and tested in KE. The impeller was the first prototype supplied on Project CG-775. Cavitation damage was noted while in KE Area and the impeller was replaced with a second prototype and the original was returned to the vendor for repair. This repaired unit was installed in KW along with a new low lift pump to accomplish an incremental increase in reactor production as authorized by Project CGI-883.

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PROTOTYPE TESTING

The prototype low lift and high lift pumps were thoroughly tested and complete head capacity and efficiency curves were determined. Figure 1 shows the data obtained for the low lift pump.

The pump characteristics were determined using the first prototype high lift pump. High accuracy laboratory type instruments were used for all measurements. The KE process water system characteristics were such that the low lift pump operating point was 37,200 gpm at a total head of 127 feet. The pump efficiency at this point is 86.7 percent.

Spot Check

In February 1960 authorization was received to modify one process pump set in KW area to provide an incremental increase in reactor production. Process pump set No. 1 was modified to accomplish this. The low lift and high lift pumps were modified and placed in service in August 1960. The low lift pump was identical to the KE prototype except that the impeller vanes had been hand finished to a very smooth surface. This special finish was specified to determine if pump efficiency and operating characteristics could be improved over that of an impeller with the normal commercial finish such as the KE impeller. The high lift pump impeller was the first prototype wheel that had been installed, tested and removed from service in KE area.

After start-up of the modified KW pump it was noted that the total process water flow was somewhat higher in KW than in KE. It was felt that the polished low lift impeller might be contributing to greater KW flow and arrangements were made for a spot check of each of the modified low lift pumps. On April 3, 1961 this spot check was made utilizing one set of instruments for measurements in both areas. Prior to taking the measurements the modified pumps were adjusted for equal impeller clearance to insure that each unit was as near identical as possible. The results of this spot check is as follows:

	KE	KW
Total head in ft.	126.8	132.6
Flow in gpm	37,400	38,000
Pump speed in rpm	589	589
Brake Horsepower	1382	1427
Water Horsepower	1197	1272
Pump Efficiency	86.7%	88.6%

For comparison with earlier data, the above information is noted on the pump curve, Figure 1. A comparison of the total head produced by each pump indicates that the KW unit operates with approximately six feet more head and approximately two percent higher efficiency than the KE unit. This higher head and efficiency is attributed to the impeller finish since all other variables; such as impeller setting, diameter, and speed, were as near identical as manufacturing and construction practices will allow. Experience within the pump industry supports the conclusion that smoothing of the impeller passages will increase pump efficiencies from two to three percent.(1)

(1) Centrifugal and Axial Flow Pumps, 2nd Edition,
pp 203, A. J. Stepanoff

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The increased head of the low lift pump will contribute an equal amount to the total system head. With system characteristics remaining constant the increased head will produce an equivalent increase in system flow if all units have polished impellers. This additional flow is estimated to be from 500 to 700 gpm more. Furthermore, due to increased pump efficiency, the increased flow can be gained without an equivalent increase in output horsepower for the uprated drive motors which are operating near their maximum capability.

Figure 2 shows the process water system characteristics with the flow expected to be realized if low lift pumps identical to the KE unit are installed. Superimposed on the characteristic curve is the flow expected if all low lift pump impellers are hand polished to provide top performance characteristics.

From the above it is concluded that hand polishing the low lift impeller will increase the process water system flow capabilities an additional 500 to 700 gpm with a resultant increase in reactor production capabilities. Using the conservative figure of \$125/gal/yr. the expected value of the increase is \$62,500 to \$87,500 per area.

A further benefit of the polished low lift impellers would be to increase the back-up emergency cooling water flow rates. Two low lift pumps in each area serve as the secondary reactor cooling system and provide emergency cooling to the reactor upon loss of the primary system. Low lift pumps equipped with the polished impellers will provide an additional emergency cooling water flow of about 500 to 1000 gpm.

FIGURE I

FIG. 2 - RELATIONSHIP OF POLISHED AND COMMERCIAL FINISHED LOW LIFT PUMP IMPELLERS TO SYSTEM CHARACTERISTICS

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