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Parametric Study for MOV Performance Improvement Using PPM Program

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1. Introduction

Nuclear power plants mainly use Air Operated Valve(hereinafter referred to as AOV) and Motor Operator Valve(hereinafter referred to as MOV) for protecting system, blocking and controlling flow. These valves have to use their function to the full in design basis accidents. Especially, MOV should have sufficient performance because it is primarily in charge of performing safety function in an emergency. Field test(static, dynamic test) results and performance prediction program are used to evaluate if MOV currently installed on nuclear power plants has the operational performance. If there are insufficiently MOV performance based on evaluation result, the way of increasing actuator capability or decreasing required thrust/torque is used to improve performance.

There is a way to replace with the actuator having a large output to raise output of actuator, but the difficulty lies in the redesign and recalculation of the piping weight as actuator size bigger than before. The technique to decreasing required thrust/torque therefore is generally used to improve operational performance of MOV. In the early days, the differential pressure decreasing method of valve forward and backward through the detailed calculation of differential pressure was used to improve operational performance of MOV, but an improvement of operational performance through replacement of aging parts is being applied in the recent periodic verification test. Therefore, to improve operational performance of MOV, this study selects important variables that affect required thrust/torque using PPM(Performance Prediction Methodology), which is a performance prediction program and draws measures to improve MOV performance.

2. Methods and Results

The improvement of operating performance for Flexible Gate valve was confirmed on changing input variables of performance program(PPM). PPM program is a performance prediction program developed by the EPRI(Electric Power Research Institute) and used as the dynamic test alternative to verify MOV operational performance. PPM was performed using information of design criteria, static diagnostic test and the results of the data acquisition. Variables affecting stem thrust of the input parameters in PPM was selected and PPM was done with changes to values. Whether MOV operational performance has improved was analyzed as PPM performance outcome before into variables in comparison with the consequences of that change.

2.1 Design Basis Information of Valve

The information of design basis about Flexible Gate Valve is summarized in the following Table I.

Table I: Design Basis Information

Item	Description
Disk Type	Gate Valve(Flexible)
Disk Size	3inch
Flow Type	Pumped flow
Difference Pressure	100psid
Safety Function	Close

2.2 PPM Input Information

The critical input information for performing PPM of Flexible Gate Valve is summarized in the following Table II.

Table II: PPM Input Information

Item	Description
Disk Guide Surface Material	Carbon Steel
Disk Seat Surface OD	7.04inch
Disk Seat Surface ID	5.61inch
Disk Seat Angle	10.2degree
Edge to Stem Angle	45degree
Stem Diameter at Packing	1.26inch
Body Guide Surface Material	Carbon Steel
Torque Arm Length	1.125
Full Stroke Length	6.25in
Packing Load, Closing Stroke	1851lbf
Stem Pitch/ Lead	0.25/ 0.25inch

2.3 PPM Performing Results

PPM was performed using analysis results of design basis and data acquisition of Flexible Gate Valve. The results of PPM performance is schematized in Figure 1 and 2. Figures 1 and 2 illustrate that the results of PPM performance show an increase of the differential pressure and stem thrust at the moment disk and seat met when the safety function valve performs closing stroke.

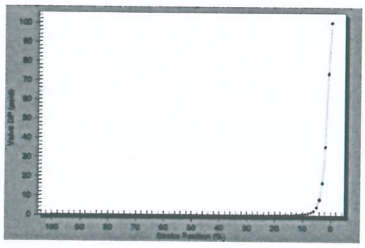

Fig. 1. Signature Valve DP vs. Stroke Position

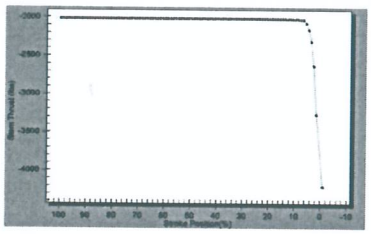

Fig. 2. Signature Stem Thrust vs. Stroke Position

2.4 PPM Parametric Study

The parameters that will affect MOV operational performance of the parameters inputted into PPM are selected as key parameters(Table III). Stem Pitch/Lead has an effect on the inertia effect and stem factors. Disk Seat Angle and Edge-to Seat Angle have effects on stem thrust by influencing friction.

Table III: Selected Parameters

Parameters	Value
Stem Pitch/Lead [inch]	0.25/0.25
Disk Seat Angle [degree]	10.2
Edge-to Seat Angle [degree]	45

Table IV: PPM Input Information

Parameters	Value
Stem Pitch/Lead [inch]	Case 1 : 0.2/0.2 Case 2 : 0.2/0.4 Case 3 : 0.3/0.3 Case 4 : 0.3/0.6
Disk Seat Angle [degree]	Case 5 : 9.2 Case 6 : 11.2
Edge-to Seat Angle [degree]	Case 7 : 30, 60, 90

The PPM by changing the value to Table IV about the selected parameters was performed. The results that the results of changes about stem thrust by performing PPM into the results analyzed about closing stroke, safety function are summarized in the following Table V.

Table V: Analysis Result

Item	Rate of Change of Stem Thrust	
	Close 0%	Close100%
Case 1	- 0.2%	- 0.2%
Case 2	0.8%	1.0%
Case 3	0.1%	0.3%
Case 4	1.6%	2.2%
Case 5	0.0%	- 2.5%
Case 6	0.0%	2.7%
Case 7	0.0%	0.0%

$$\text{Rate of Change of Stem Thrust(\%)} = \frac{(\text{Stem Thrust}_{\text{after}} - \text{Stem Thrust}_{\text{before}})}{\text{Stem Thrust}_{\text{before}}} \times 100$$

When Stem Pitch/Lead became smaller, stem thrust also did. Stem thrust grew when the Stem Lead became longer while Stem Pitch grew smaller. The stem thrust increased when Stem Lead was longer despite having equivalent Stem Pitch. It seems that stem thrust became bigger as the Stem Lead got increased and stem factor grew worse. The stem thrust was changed because of influencing on friction directly when the Disk Seat Angle changes, Case 1 and 5 only in the Table 5 show that the stem thrust decreased.

3. Conclusions

There are several methods through reviewing design basis, changes operating procedures and maintenance work of stem(or packing, etc.) to improve operating performance of MOV generally installed in the nuclear power plants.

This study verified the changes of the MOV operating performance through the improvement of stem and hydraulic parts(seat, guide etc.). Especially, MOV operating performance was much greater improved when the Disk Seat Angle was decreasing. Generally, improvement work to minimize friction of seat, disk and guide is limited and dynamic diagnostic testing has to be performed with change in valve factor for improvement of hydraulic parts(seat, guide etc.). Parametric study through more tests and data analysis should be done to improve more clearly MOV operating performance for the next.

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