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Failsafe Revival Test for Knife Gate Valves with Electro Pneumatic Positioners

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ABSTRACT

Processing applications work on the principle of metered flow of working media to ensure accurate execution of the processes in the further stages. These may include food or raw material processing units that are highly concerned about the quantity of flow media passing through a given section in a given period of time. Foe specific applications, higher precision is required when it comes to the percentage of opening of the flow area as the same is directly proportional to the success of the process. In such cases, special accessories called positioners are used that can position the valve trim components to a desired extent to initiate the necessary percentage opening of flow. This paper shall focus on such positioners mounted on Knife Gate Valves and their ability to deliver precision in the opening percentage. The condition considered shall be that of a failsafe revival requirement wherein during operation, if there is failure of electric power or air supply, the valve shall act according to the set failsafe condition and once the electric power or air supply is restored, the valve opens to the same opening as it was before the said failure. This can clearly demonstrate the property of precision of the positioner. In order to ensure wider applicability, four such positioners shall be considerde and an experimental procedure shall be put forward and followed accordingly. The results obtained shall be described in the form of graphs and a conclusion shall be drawn accordingly towards the end.

KEYWORDS: *Valve, electro, pneumatic, positioner, failsafe*

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A. Introduction to Electro Pneumatic Positioners in Knife Gate Valves

Knife Gate Valves are one of the most versatile valves used in a wide variety of demanding applications right from solid particles' handling to sludge and slurry. These valves are also suitable for processing industries including packaging and distribution of materials.

At times, there is a requirement of a precise percentage of opening of the valve gate to ensure calculated amount of flow media is passed on to the next section of flow. Electro Pneumatic Positioners aid this operation by their ability of precise control.

Positioners may be smart or manual. Smart positioners are included with electronic circuits to enable auto calibration using a suitable feedback module. Manual positioners need manual calibration and maintenance from time to time.

However, it is necessary to establish the ability of the positioner to perform as desired in various conditions. This paper shall consider one such case being the fail safe revival.

B. Failsafe Revival test

Knife Gate Valves that are operated pneumatically can be designed to suit various failsafe conditions that include fail to open, fail to close and fail to stay put in case of failure of electrical power or air supply or both.

However, it is required that when electro pneumatic positioners are mounted to valves with an intended fail safe system, once the electrical power or air supply is resumed, the valve should immediately open to the exact same percentage of opening as it was at the time of failure of supply electricity or air.

This dictates the ability of the positioner to precisely locate the percentage of opening and position the trim physically at the same. This test can be employed to ensure the precision of the electro pneumatic positioner.

C. Significance of the test and effect on the application

Pneumatic Actuated valves are used in Lines where quicker actuation is required. However, precision flow applications that involve chemical reactions, mixing of substances and time dependent applications require accurate percentage of opening of the valve which is timed with the net output of the plant.

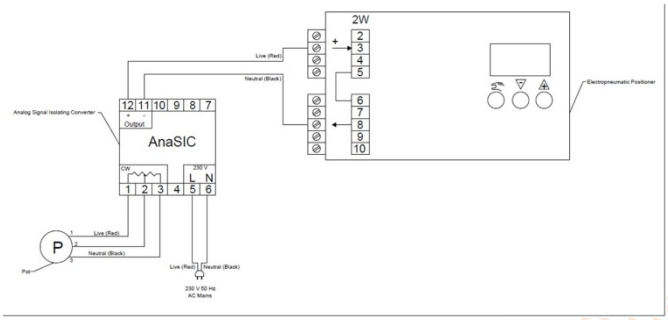
During the working, despite of power backup, there may be instances where the electrical power supply may get cut off. Depending on the application, in such a situation, it is required that either the valve door remains static or opens or closes. The pneumatic circuit can be designed accordingly to facilitate the fulfillment of this requirement.

While working with positioners, an additional requirement is that once the power supply is restored, the valve should open to the same degree of opening as it was earlier. This itself has been the reason for carrying out this test. This test can dictate the precision with which the valve can open to the same level once the power supply is restored.

D. Testing Procedure

Following step by step testing procedure can be followed to carry out the experiment and note the results. Before the experiment is started, the Pneumatic Connections are completed according to the customer requirement of failsafe to open or close by referring the Calibration procedure. The readings have been taken at opening values nearer to multiples of 5 to maintain the randomness to confirm the success of the revival test.

Step 1: Complete the electrical circuit connections according the instructions manual in the presence of trained personnel. Following diagram may be used as a reference.



Step 2: Set the calibrated positioner to AUTO display mode so that the variable Pot 'P' can be operated to actuate the positioner

Step 3: Using the pot set the Positioner display to 0.0 . Switch off the power supply. After a gap of 2 seconds, switch on the power supply and note down the reading on the Positioner display

Step 4: Rotate the Pot clockwise by half a rotation to obtain any value nearer to 5.0 on the Positioner display. Switch off the power supply. After a gap of 2 seconds, switch on the power supply and note down the reading on the Positioner display

Step 5: Rotate the Pot clockwise by another half rotation to obtain any value nearer to 10.0 on the Positioner display. Switch off the power supply. After a gap of 2 seconds, switch on the power supply and note down the reading on the Positioner display

Step 6: Repeat this procedure with steps of half rotations of the pot, switching off the current, then switching it on and noting down the displayed reading for the entire range of the Positioner

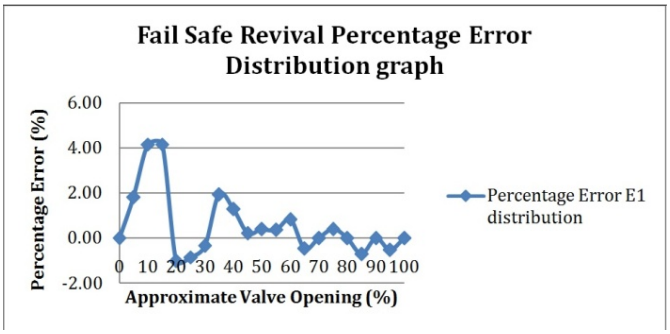
Step 7: Compile the data and analyze the same

E. Results and Discussions

This section shall include the compilation of errors observed with respect to the observed percentage opening and the required percentage opening for various percentage opening. The data has been presented in the form of graphs for enhanced comprehension and associated visualisation.

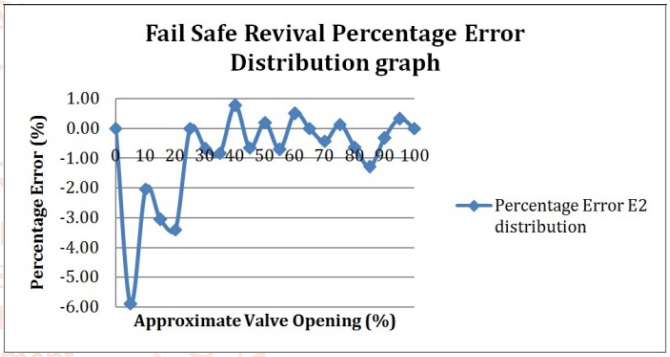
The make of Electro Pneumatic Positioners used for this experiment was SIEMENS and the model used was 6DR5223 Smart Positioner. The results obtained have been presented graphically in the following sections.

E.A. Failsafe Revival test for valve 1 of 4



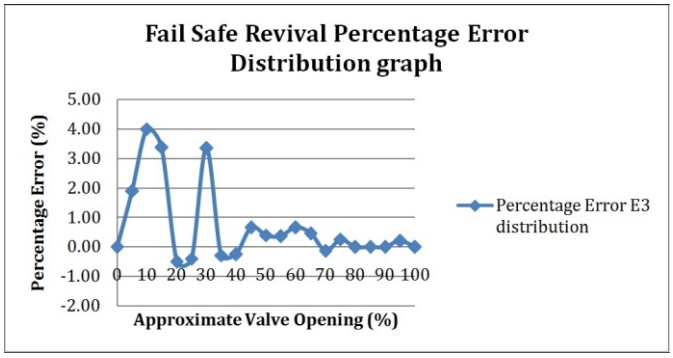
It can be observed from the graph that initially, the positioner exhibits an error in the range of nearly 5% which gradually decreases as the opening increases. This error can be accepted because the valve is required to be operated at an opening of greater than 50% for majority of the time in majority of the applications.

E.B. Failsafe Revival test for valve 2 of 4



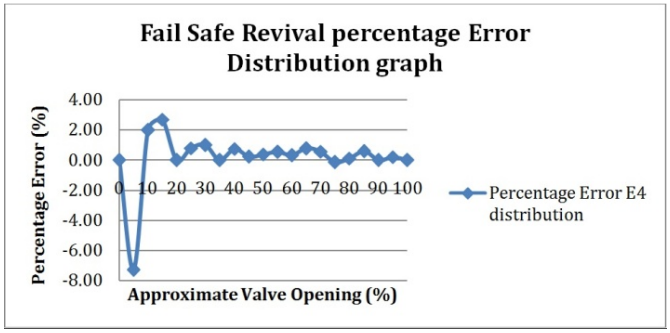
It can be observed from the graph that the maximum percentage error is observed for smaller openings up to 30% after which, there is a considerable stability observed in the error distribution. This error can be accepted because the valve is required to be operated at an opening of greater than 50% for majority of the time in majority of the applications.

E.C. Failsafe Revival test for valve 3 of 4



It can be observed from the graph that the maximum percentage error is observed for smaller openings up to 30% after which, there is a considerable stability observed in the error distribution. This error can be accepted because the valve is required to be operated at an opening of greater than 50% for majority of the time in majority of the applications.

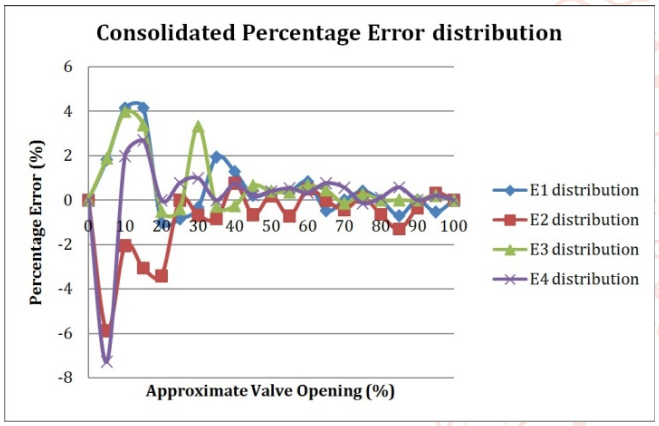
E.D. Failsafe Revival test for valve 4 of 4

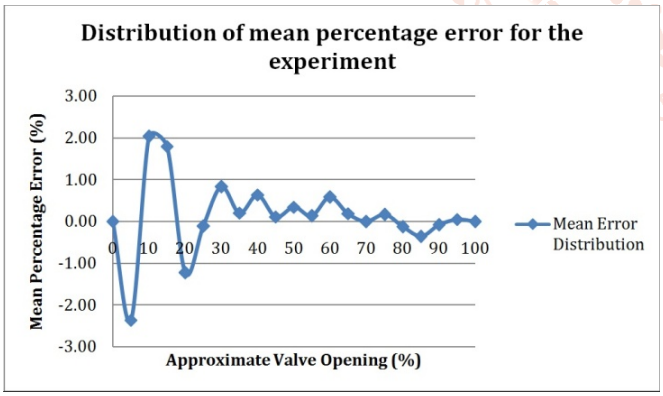


It can be observed from the graph that the maximum percentage error is observed for smaller openings up to 20% after which, there is a considerable stability observed in the error distribution. This error can be accepted because the valve is required to be operated at an opening of greater than 50% for majority of the time in majority of the applications.

E.E. Analysis of Error distribution

Following graphs indicate the consolidated distribution of error and the mean error observed during the overall experiment.





It can be clearly observed from the consolidated graph that there is larger range of error for smaller opening of the valve while as the percentage of valve opening increases; the percentage error is nearer to zero and is found to stabilize. The variable error can be attributed to factors like variable friction of the gland packing from valve to valve, surface roughness of the seat surfaces, lubrication and fitment of the pneumatic actuator piston-cylinder arrangement, alignment of the parts, Feedback module of the positioner and play between the parts on account of tolerances. However, operationally these factors may not hinder the performance of the valve once the same is connected to the SCADA system at the site which comes under the automated control through a PLC.

The mean error distribution replicates the individual performances in a consolidated manner. The maximum percentage error observed is found to be -2.36% at an opening of 5%. This attributes to an error of 0.6 mm max which can be accepted considering the tolerance between the Gate clamper and the Top surface of the gate.

Thus the valve faithfully exhibits the desired characteristics of failsafe revival and opens to a precise degree of opening within the acceptable limits.

Conclusion

Thus it can be concluded that Failsafe revival ability of the Positioners under study has been confirmed and the positioners are found to deliver the same with faithful outputs within the acceptable limits with a maximum mean percentage error range of 4.39% and a minimum mean percentage error range of 0.05%. Thus the Positioner can be commissioned for an application that demands failsafe to open or close condition as per customer requirement.

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This paper in no means intends to advertise or promote any brand or make of electro pneumatic positioners. The models and brands considered have been chosen at random to ensure applicability of the experimental procedure and results thereof to a wide variety of similar equipment.