Diagnostic Software Supporting Condition-Based Maintenance of Control Valves

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To improve the stability of plant operation we developed PLUG-IN Valstaff, an application supporting the maintenance of control valves, which occupy an important place in plant maintenance operations. PLUG-IN Valstaff makes use of the diagnostic functions of Azbil Corporation's new Smart Valve Positioner 700 series, enabling advance detection of the symptoms of deterioration and abnormality. In addition, an analysis service for diagnostic data allows users to plan an appropriate maintenance schedule and effectively reduce maintenance costs and maintenance time.

1. Introduction

Since control valves directly control the process fluid, if there is a problem with a valve, it will greatly affect plant operation. Thus, maintenance of control valves is very important for maintaining steady plant operation. On the other hand, changes in the economic situation due to global competition, industrial reorganization, etc., have heightened the need to cut equipment maintenance costs, putting pressure on plant maintenance departments to be more efficient.

Generally, equipment failure rates change according to equipment age along what is called a "bathtub curve." Failures can therefore be classified into three stages: the early failure period, random failure period, and wear-out failure period, the latter being the period when the failure rate increases as time passes.*1 To prevent wear-out failures, time-based maintenance (TBM, periodic maintenance based on operating time) is usually used. However, a problem with TBM is that, if the maintenance interval is shortened to reduce the failure rate, maintenance costs and the risk of failure immediately after maintenance both increase.

To avoid the problems with time-based maintenance, it is desirable to use condition-based maintenance (CBM), in which maintenance measures can be planned based on the monitoring of equipment condition and detection of symptoms of abnormality. Since, with CBM, unnecessary maintenance work is not done while the equipment is working reliably, a reasonable maintenance interval and reliable equipment operation can coexist, and maintenance costs can be cut.

With these considerations in mind, Azbil Corporation developed its 300 and 700 series smart valve positioners and equipped them with a control valve diagnostic function. In addition, the company developed a control valve maintenance support system, PLUG-IN Valstaff, to support condition-based maintenance that makes use of this diagnostic function. PLUG-IN Valstaff has functions that support the diagnosis of long-term deterioration based on history data collected during plant operation, as well as adjustment and test functions that help to prevent initial failures after shutdown maintenance. This paper describes the functions that are available to support CBM during both plant shutdown and plant operation. In addition, it explains Azbil Corporation's valve diagnostic analysis service, which is based on the data collected by PLUG-IN Valstaff.

2. Valve diagnostic function of the 300/700 series of smart valve positioners

Azbil Corporation's smart valve positioners have a valve diagnostic function that monitors the condition of control valves so that signs of abnormality or malfunction can be detected at an early stage. Utilizing this function, maintenance staff can easily determine the optimal time for maintenance.

The 300 series calculates diagnostic indexes to find symptoms of control valve abnormality or deterioration based on valve travel data. If an index exceeds the specified threshold, an alarm is generated, supporting early detection of abnormalities.[*2]

To provide more advanced diagnostic functions, the 700 series is equipped with a pressure sensor that is used to monitor the supply air pressure, back pressure, and positioner output air pressure. Newly added diagnostic functions detect abnormalities associated with valve closing, the actuator, friction, etc.[*3]

3. The development of PLUG-IN Valstaff

3.1 Monitoring of field instruments by the device management system

As the scale of a plant increases, the number of field instruments multiplies and the area of installation expands, and it becomes impractical to manage each field instrument individually. In recent years digital communication with field instruments using communication protocols like HART and FOUNDATION Fieldbus has become possible, and device management systems have come into wide use in order to manage field instruments centrally on a host computer. The device management system constantly monitors the condition of connected field instruments and informs the maintenance staff when an abnormality arises. Because the system can also access the parameters of the field instruments, the maintenance staff can check the condition of the field instruments, as well as checking and changing their settings.

3.2 Condition diagnosis by PLUG-IN Valstaff

Field instruments, however, because of hardware restrictions, are not suited for long-term accumulation of data or for calculations using external data. Therefore, they are generally unable to execute advanced diagnosis by themselves. Device management systems, on the other hand, are well suited for data accumulation and calculation, but because they handle a wide variety of field instruments, it is not easy for them to handle the diagnosis of certain instrument characteristics.

With this background in mind, PLUG-IN Valstaff was developed to be an application that can make the most of the control valve diagnostic functions of Azbil Corporation's smart valve positioners, thus improving the maintenance of control valves, which are a critical element for reliable plant operation. PLUG-IN Valstaff is plug-in software that expands the functions of device management systems. It runs on InnovativeField Organizer™, which is made by Azbil Corporation, or on Plant Resource Manager (PRM), a product of Yokogawa Electric Corporation.

4. Functions supporting condition-based maintenance

PLUG-IN Valstaff provides online and offline diagnosis using the control valve diagnostic functions of Azbil Corporation's smart valve positioners.

Online diagnosis works while the plant is operating, collecting diagnostic parameters calculated from valve operations, and checking for deterioration over time. Offline diagnosis, on the other hand, checks the operation of control valves for potential problems while the plant is shut down, when tests can be run without valve travel limitations.

This section describes how the diagnostic functions are used, presenting examples of typical uses both during plant shutdown (including preparation for maintenance before shutdown) and during plant operation.

4.1 Using the diagnostic results for shutdown maintenance

Utilizing the above-mentioned diagnostic functions, a shutdown maintenance plan can be drawn up based on the condition of the control valves. It is very important to select which control valves will be serviced, especially in the case of those requiring an overhaul. Using PLUG-IN

Valstaff, priorities can be assigned to the valves and selection can be made based on the diagnostic data. In addition, if the online diagnostic data is analyzed before shutdown maintenance, preparation for maintenance (scheduling and procuring of maintenance materials) can shorten the shutdown maintenance period and allow highly accurate cost estimation.

4.1.1 Valve selection based on online diagnosis

This section describes how online diagnostic data is used in control valve maintenance.

To enable the assignment of priorities to control valves, Valstaff outputs diagnostic reports for all valves, describing online diagnostic parameters and the number of alarms (see further 4.2.3). By sorting the control valves according to the value of the online diagnostic parameters and the number of alarms, it is possible to select those that have a high risk of failure. In the following, diagnostic parameters that are important from three different viewpoints, and the associated abnormalities, are described.

a. Valve travel

Control valves with a large amount of total valve travel or a high cycle count are under a relatively heavy load. Accordingly, these control valves have a high probability of failing from causes such as process fluid leakage from worn gland packing or control failure due to a broken actuator diaphragm.

b. Fluid leakage

If there have been many stick-slip alarms (repeated stopping and slipping of the valve stem) for a control valve, it is likely that the stem is not sliding smoothly because of a problem such as excessive friction with the gland. Excessive friction in the gland section means that a large load is being applied to the gland packing, raising the possibility of structural failure of the gland packing accompanied by leakage of the process fluid. Also, if a control valve's zero travel diagnosis shows many minus direction alarms, there is a high probability that the seat ring is worn. If erosion causes abrasion of the seat ring, the valve body itself can be expected to be worn, meaning that the risk of process fluid leakage is high. In addition, if a control valve has many temperature alarms, the temperature of the process fluid may be affecting the internal temperature of the valve positioner, implying a leak of process fluid from somewhere in the control valve.

c. Abnormality of the air supply piping

A supply pressure alarm for a control valve indicates that the pressure of the compressed air supplied to the positioner is lower than when the positioner was initially adjusted. In this case, leak checks for the control valve itself and the air supply piping near the valve are recommended. Also, if there is a positioner air circuit alarm, the internal air circuit may be clogged due to dirty supply air.

Control valves with a high score for the checks mentioned above are probably undergoing deterioration and are candidates for maintenance. On the other hand, control valves that have good diagnostic results, that do not have a high score on any of these checks, have a small risk of failure and can be left off the maintenance list.

However, for critical control valves whose failure can lead to a serious accident, the necessity of maintenance should be judged not only on the basis of the diagnostic results mentioned above, but also on broader considerations.

4.1.2 Valve selection based on offline diagnosis

The role of offline diagnosis for control valve maintenance is discussed below. As mentioned previously, online diagnosis is conducted while the plant is operating, so the range of control valve travel is often limited by the operating conditions. For this reason, offline diagnosis is used to detect potential control valve problems that are hard to find during online diagnosis.

As the first step in offline diagnosis, after the plant is shut down a step response test (ON-OFF step and 25 % steps) and valve signature are executed. The latter is based on the relationship between the valve opening and pressure of the actuator, and is done by changing the control valve condition slowly from fully closed to fully open, and back to fully closed. Next, a Step Response Test Result Summary Report (figure 1) and Valve Signature Result Summary Report (figure 2) are output for all control valves.

By checking the result column of these diagnostic summary reports, the user can easily identify the control valves with poor diagnostic results.

The following sections provide some details on the step response test and valve signature.

(1) Step response test

a. ON-OFF step

This test is conducted by a positioner so that the control valve travels from the fully closed position to the fully open position.

It can detect slow valve operation or a critical failure that prevents valve travel from 0 to 100 %. Since this kind of phenomenon indicates possible galling in the sliding parts or a drop in supply air pressure, overhauling the valve is recommended.

Step Response Test Result Summary Report

PLUG-IN Valstaff Report
Printing Time: 12/12/2014 18:47:24

	Judgment Reason		Judgment Reason		Judgment Reason		Judgment Reason
A	Achievement	Z	Zero Travel	D	Deviation	S	Settling Time
E	Overshoot / Undershoot	T	Travel Speed	H	History-Based		

Device Tag	Test Pattern	No. 1		No. 2		No. 3		No. 4		No. 5		Diagnostic Results		History-Based Diagnosis
		Date	No. of Executions	Date	No. of Executions	Date	No. of Executions	Date	No. of Executions	Date	No. of Executions	Result	Judgment Reason	Reference Data Start Time
AP12FV001	Small_25STEP	12/13/2014	1	12/12/2014	1	12/11/2014	1	12/10/2014	1	12/09/2014	1	Pass		
AP12FV001	Small_ON-OFF	12/13/2014	1	12/12/2014	1	12/11/2014	1	12/10/2014	1	12/09/2014	1	Pass		
AP12FV002	Small_25STEP	12/13/2014	1	12/12/2014	1	12/11/2014	1	12/10/2014	1	12/09/2014	1	Pass		
AP12FV002	Small_ON-OFF	12/13/2014	1	12/12/2014	1	12/11/2014	1	12/10/2014	1	12/09/2014	1	Pass		
AP12FV003	Small_25STEP	12/13/2014	1	12/12/2014	1	12/11/2014	1	12/10/2014	1	12/09/2014	1	Check	E	
AP12FV003	Small_ON-OFF	12/13/2014	1	12/12/2014	1	12/11/2014	1	12/10/2014	1	12/09/2014	1	Pass		
AP12FV004	Small_25STEP	12/13/2014	1	12/12/2014	1	12/11/2014	1	12/10/2014	1	12/09/2014	1	Pass		
AP12FV004	Small_ON-OFF	12/13/2014	1	12/12/2014	1	12/11/2014	1	12/10/2014	1	12/09/2014	1	Pass		

Figure 1. Step Response Test Result Summary Report (ON-OFF step and 25 % steps)

Valve Signature Result Summary Report

PLUG-IN Valstaff Report
Printing Time: 12/12/2014 18:48:52

	Judgment Reason		Judgment Reason		Judgment Reason
1	Seating force tends to be insufficient.	4	Check Spring Range Shut	7	EPM drive signal tends to slip.
2	Friction tends to increase.	5	Check Spring Rate / Spring Span		
3	Friction tends to decrease.	6	Stick-slip tendency		

Device Tag	Test Pattern	No. 1			No. 2			No. 3			No. 4			No. 5		
		Start Time	Result	Judgment Reason	Start Time	Result	Judgment Reason	Start Time	Result	Judgment Reason	Start Time	Result	Judgment Reason	Start Time	Result	Judgment Reason
AP12FV001	(Auto)	2014/12/10 19:30	Pass		2014/12/09 19:30	Pass		2014/12/08 19:30	Pass		2014/12/07 19:30	Pass		2014/12/06 19:30	Pass	
AP12FV002	(Auto)	2014/12/10 19:36	Pass		2014/12/09 19:30	Pass		2014/12/08 19:30	Pass		2014/12/07 19:30	Pass		2014/12/06 19:30	Pass	
AP12FV003	(Auto)	2014/12/10 19:42	Pass		2014/12/09 19:30	Pass		2014/12/08 19:30	Pass		2014/12/07 19:30	Pass		2014/12/06 19:30	Pass	
AP12FV004	(Auto)	2014/12/10 19:48	Check	2	2014/12/09 19:30	Pass		2014/12/08 19:30	Pass		2014/12/07 19:30	Pass		2014/12/06 19:30	Pass	
AP12FV005	(Auto)	2014/12/10 19:54	Pass		2014/12/09 19:30	Pass		2014/12/08 19:30	Pass		2014/12/07 19:30	Pass		2014/12/06 19:30	Pass	
AP12FV006	(Auto)	2014/12/10 20:00	Pass		2014/12/09 19:30	Pass		2014/12/08 19:30	Pass		2014/12/07 19:30	Pass		2014/12/06 19:30	Pass	

Figure 2. Valve Signature Result Summary Report

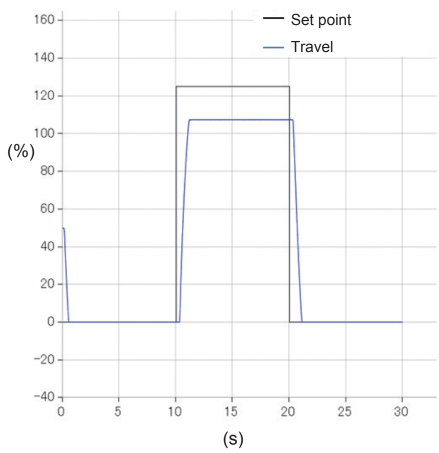


Figure 3. Results of ON-OFF step

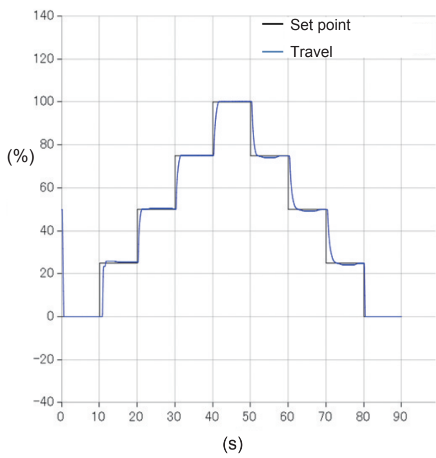


Figure 4. Results of 25 % steps

b. 25 % steps

In this check, the set point is changed in steps as follows: 0—25—50—75—100—75—50—25—0 %.

At each step, judgments are made concerning step response parameter data such as the deviation, settling time, and overshoot. If these parameters have become larger, the control performance has probably deteriorated because friction has increased since the positioner was adjusted. Reexamining the control parameters of the positioner, or a maintenance procedure such as replacing the gland packing of the control valve, is recommended.

(2) Valve signature

The step response test discussed above is used mainly to detect whether the dynamic characteristics of the control valve have deteriorated. Valve signature, on the other hand, focuses on deterioration of the static characteristics of the control valve.

Valve signature is done as the control valve slowly travels from the fully closed position to the fully open position, and then slowly returns to the fully closed position.

The data collected during this test is shown in figure 5, where supply pressure to the actuator is shown on the horizontal axis and valve travel on the vertical axis. Using this graph, calculations can be made for factors like the following in order to detect a problem with the control valve.

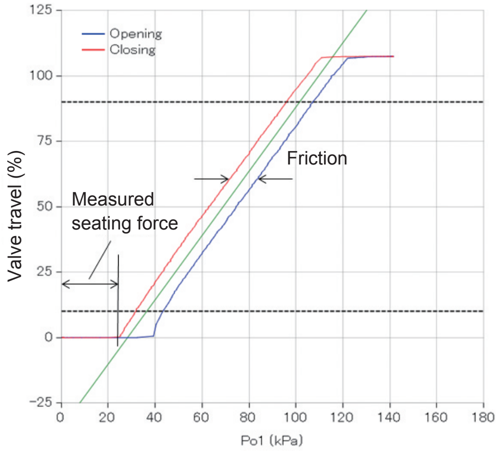


Figure 5. Results of Valve Signature

a. Seating force

The seating force, which is the force exerted on the seat of the control valve by the plug, is used to determine whether leakage of the process fluid from the seat is within standards (IEC, etc.) when the valve is fully closed. The seating force is calculated by deriving the expected fluid force from the measured seating force shown in figure 5. If this value does not meet the threshold, it is probable that valve seat leakage exceeds the specified value. Insufficient seating force can be caused by inclination of the actuator spring or insufficient supply pressure. Alternatively, the specifications selected for the control valve may not be suitable.

b. Friction

In a control valve, friction is generated between the sliding stem and the gland packing. Valve signature calculates the friction using the difference in supply pressure to the actuator between the valve opening and closing directions (= the distance between the opening and closing lines in figure 5). If the friction exceeds the threshold, the gland packing's characteristics are impaired such that there is more resistance to sliding, indicating that a heavy load is applied to the gland packing. If the plant resumes operation under these conditions, the gland packing may fail structurally, allowing process fluid to leak. In this case, countermeasures such as replacement of the gland packing must be taken.

c. Stick-slip

If there is a problem with the sliding elements of a control valve, stick-slip may occur. Stick-slip is checked during valve signature as well as during online diagnosis. If a control valve's diagnostics parameter for stick-slip are high and exceed the preset threshold, there is likely to be deterioration of the sliding parts, implying a high risk of failure.

As stated above, by conducting step response testing and valve signature and by outputting a summary report for the results, control valves with a potential failure can be selected.

However, it is important to note that what the valve signature detects are the static characteristics of the control valve after plant shutdown. Failures occur only when the plant is operating, and conditions are different before and after plant shutdown. For this reason, the 700 series has online diagnostic functions,*3 namely "P_o Validity" and "Max Friction," on which see section 4.2.1.

4.2 Using the diagnostic functions during plant operation

This section describes how to use the diagnostic functions to support maintenance of control valves during plant operation.

Positioners can generate alarms based on diagnostic parameters and preset thresholds. The user can then check through the user interface of the device management system, make a judgment as to the condition of the control valve, and take countermeasures. Even if no alarms occur, periodic inspections (e.g., once a month) may be implemented to check valve condition and any changes in control valve trends.

PLUG-IN Valstaff has display and report output functions to support the above work by the user.

4.2.1 Analyzing the cause of a diagnostic alarm

Taking as an example a diagnostic alarm generated by P_o Validity, this section describes how to analyze the condition of a control valve and the cause of a diagnostic alarm using Valstaff's online diagnostic screen.

As described in the previous section, valve signature cannot inform the user regarding the static characteristics of a control valve during plant operation. P_o Validity and Max Friction are provided as online functions to provide valve signature during plant operation. With these functions, the user can obtain information on the characteristics of the control valve that are affected by the process fluid force and temperature, information that cannot be obtained by valve signature during plant shutdown. The following tells how to determine the condition of a control valve when a P_o Validity alarm occurs.

If a P_o Validity alarm occurs, the past alarm situation and the condition of the control valve based on the valve signature can be checked on the screen shown in figure 6.

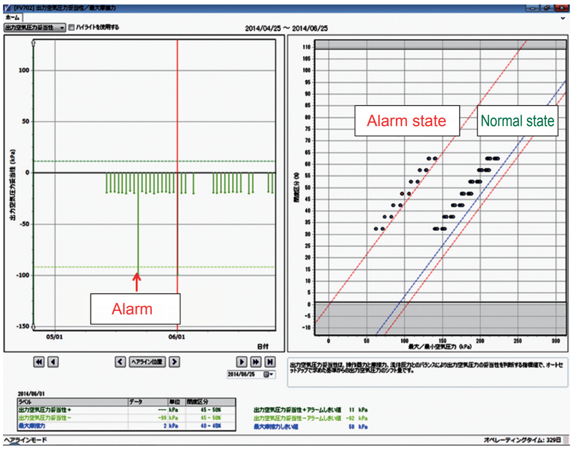


Figure 6. P_O Validity screen

The graph on the left in figure 6 shows changes in the time series of the P_O Validity parameter. This graph indicates that a single alarm occurred when the P_O Validity increased greatly (in the minus direction in this case). Since alarms did not repeatedly occur, a temporary abnormality can be inferred. In the same way as the valve signature, the graph on the right in figure 6 shows supply pressure to the actuator on the horizontal axis and control valve travel on the vertical axis. When operation is normal, the data points form a band on the right. When an alarm occurs, they are displaced leftward. This indicates that the output air pressure to the actuator is not correct. Accordingly, the actuator's force is too weak. In this case, because the phenomenon is temporary, it can be inferred that probably the process fluid force increased temporarily. Sizing of the control valve should be redone. If the P_O Validity index is continuously high, failure of the actuator is likely to occur. Accordingly, actuator maintenance should be planned.

4.2.2 Monitoring with visualized diagnostic indexes

PLUG-IN Valstaff provides various display functions so that the user can detect abnormal tendencies earlier during plant operation and determine whether an overhaul is needed, efficiently using diagnostic index data calculated by the positioner. For compatibility with the 700 series, PLUG-IN Valstaff was improved not only to handle diagnosis based on data from the newly added pressure sensor, but also to improve the method of index data presentation so that time series changes in the index data are more recognizable. The following are typical examples.

(1) Visualizing frequently used valve travel ranges

The travel histogram screen displays index data on the frequency of use of valve travel positions, showing the use ratio for each valve travel section, from fully closed to fully open. This data is used to learn the most frequently used valve travel range so that the user can predict the trim damage caused by low travel angle operation and can check the appropriateness of valve sizing.

By checking time series changes in the travel histogram data, the user can infer a tendency for clogging in the piping, abrasion of the seat plug, or a change in process operation status. When the index data is displayed as a heat map, changes over a long period can be grasped at a glance. In addition, this function helps the user analyze the information on the subdivided valve travel segments for the 700 series. (See figure 7.)

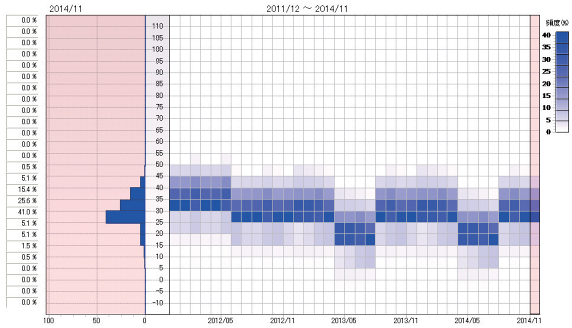


Figure 7. Travel histogram

(2) Visualizing stick-slip indexes

On the stick-slip screen, the two types of graphs that display the indexes make the occurrences of stick-slip easily understandable. On the scatter plot (top of figure 8), the distribution of index values over a long period can be checked directly. On the time-series plot (bottom of figure 8), details on the times when indexes exceed the threshold can be checked.

To help the user easily check time series changes on the scatter plot graph and the tendency for stick-slip behavior, the cursors on the two graphs are linked, and the data for the specified period is highlighted in yellow (the yellow band and data points in figure 8).

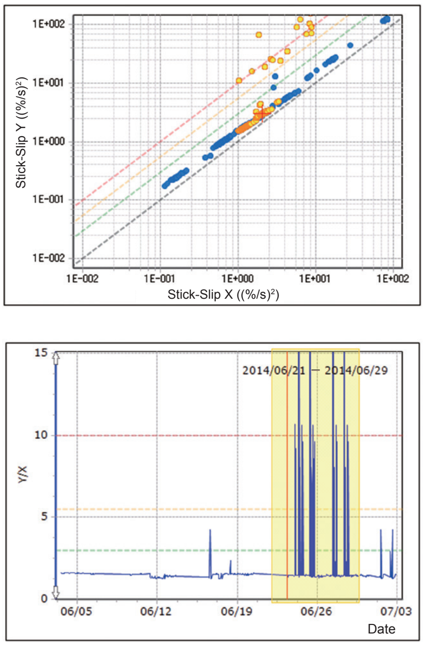


Figure 8. Visualizing stick-slip indexes

(3) Visualizing time series changes in the totalized data

For indexes like Total Stroke, Shut Count, and Cycle Count, which increase steadily during plant operation, the larger the index becomes, the less visible a tendency to increase becomes (Figure 9). Since the diagnostic screen displays time series plots and the amount of change (amount of increase per day) in an index (figure 10), the user can easily recognize the tendency of an index to increase, and therefore a change or abnormal trend in control valve operation.

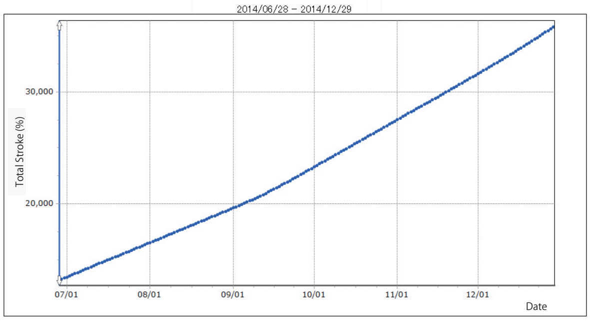


Figure 9. Visualizing time series changes in the cumulative data

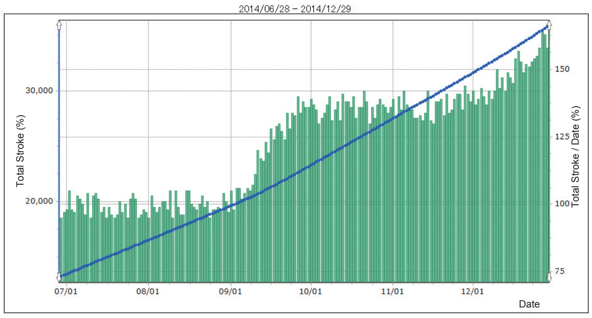


Figure 10. Visualizing the amount of change in cumulative data

4.2.3 Trend monitoring using online diagnostic reports

Even during stable plant operation, it is important to check control valve diagnostics periodically in order to detect deterioration or changes in condition at an early stage. By checking online diagnostic reports, the user can efficiently learn of changes in the condition of many control valves used in processes.

Trend monitoring using online diagnostic reports is described below.

FV702	Stick-Slip Alarms			Total Stroke (%)	Shut Count	Max. Travel Speed (%/s)		Cycles	Positioner Air Circuit Alarms	
	High	Medium	Low			+	-		+	-
05/2014	7	11	13	4236912.00	101	8.44	-7.68	103	11	19
04/2014	6	11	12	4234578.00	96	76.11	-67.97	101	10	18
03/2014	5	10	11	4236912.01	91	78.92	-23.80	81	9	18
02/2014	5	9	11	4234578.01	86	40.51	-55.02	70	7	16
01/2014	4	9	10	4236912.02	81	87.13	-62.18	70	7	13
12/2013	4	8	10	4234578.02	76	22.23	-34.86	61	5	12

Deviation Alarms		Zero Travel Alarms		Supply Pressure Alarms		Temperature Alarms		Travel Histogram				
								Days (Days)	No. 1		No. 2	
+	-	+	-	High	Low	High	Low		Travel Segment	Percentage (%)	Travel Segment	Percentage (%)
30	37	39	48	48	47	60	66	30	85% - 90%	84	-5% - 0%	8
26	32	36	44	41	42	50	56	31	85% - 90%	84	-5% - 0%	2
25	28	34	38	34	37	45	49	28	85% - 90%	73	-5% - 0%	10
22	24	32	32	30	32	42	41	31	85% - 90%	88	-5% - 0%	7
20	21	30	29	28	25	36	31	31	85% - 90%	92	-5% - 0%	6
19	18	25	27	25	19	34	25	30	85% - 90%	83	-5% - 0%	6

Figure 11. Diagnosis Report for Each Device

Device Tag	Est. Threshold Date	Total Stroke (%)					
		05/2014	04/2014	03/2014	02/2014	01/2014	12/2013
FV302	08/13/2096	176138.38	176138.38	148996.29	126934.96	111281.21	104508.17
FV702	04/03/2090	253589.39	253589.39	235532.89	231857.99	217668.67	180544.05
FV703	02/13/2062	365142.45	365142.45	325105.30	282144.32	233668.34	220320.56

Figure 12. Total Stroke Diagnosis Report (Monthly)

Device Tag	Alarm Type	Judgment	Stick-Slip Alarms					
			05/2014	04/2014	03/2014	02/2014	01/2014	12/2013
FV302	---	Increasing	6	5	5	4	4	4
FV702	High	Increasing	40	38	32	26	25	22
FV702	Medium	Increasing	29	26	23	23	23	22
FV702	Low	Increasing	34	31	28	23	20	19
FV703	High	Increasing	21	20	17	13	12	10
FV703	Medium	Increasing	18	15	12	11	10	9
FV703	Low	Increasing	13	12	11	10	10	8

Figure 13. Stick-Slip Diagnosis Report (Monthly)

The Diagnosis Report for Each Device (figure 11) lists cumulative values (Total Stroke, Shut Count, and Cycle Count) and the number of alarms (Stick-Slip, Positioner Air Circuit, Deviation, Zero Travel, Supply Pressure, and Temperature) for each control valve on a monthly basis. With this report the user can learn of time series changes for each index.

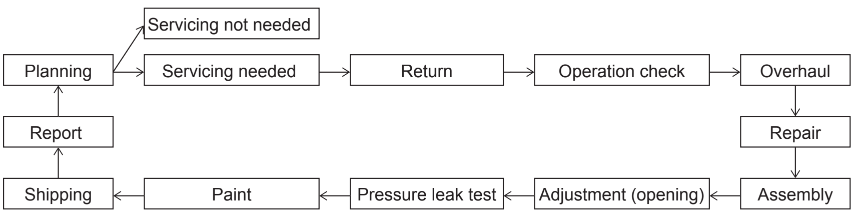
The Total Stroke Diagnosis Report (Monthly) shown in figure 12 gives the cumulative distance covered by all valve strokes for each control valve on a monthly basis. The Estimated Threshold Date, the estimated date when a threshold will be reached, is calculated from the trends in the cumulative values, and is useful for identifying valves with a high risk of failure and for determining the timing of maintenance.

The Stick-Slip Diagnosis Report (Monthly) shown in figure 13 gives the number of stick-slip alarms for each control valve on a monthly basis. From this information the user can learn of time-series changes in the number of alarms of multiple control valves. For control valves with a rising tendency in the number of alarms, "Increasing" appears in the Judgment column.

5. Future development of valve diagnostic service

5.1 Valve maintenance service promoted by the azbil Group

Industrial valves, including the control valves discussed above, have movable parts and operate 24 hours a day, 365 days a year, directly controlling the process fluid. Thus, the unexpected failure of a valve may cause the shutdown of production equipment and may also cause an accident.



Typical maintenance cycle

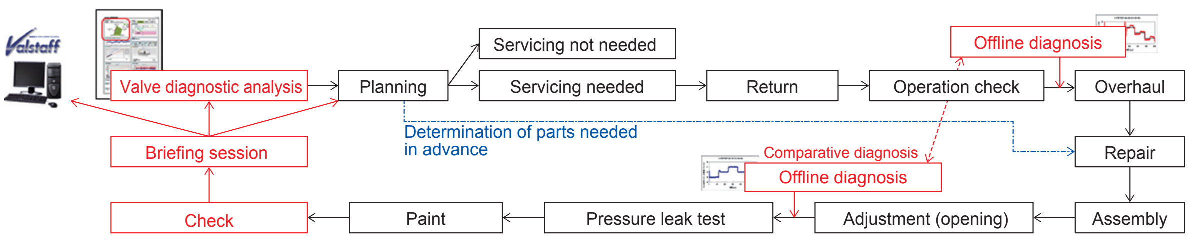


Figure 14. Standard maintenance cycle (top) and expert maintenance cycle (bottom)

Generally, by way of valve maintenance, appropriate maintenance is done on a time basis to prevent problems. Azbil Corporation offers instead an Expert Maintenance Service, a type of condition-based maintenance that combines valve diagnostic analysis with conventional maintenance.

Valve diagnostic analysis is a method of inferring valve condition by analyzing the diagnostic indexes tracked by Valstaff in combination with Azbil Corporation's know-how. It can be used for any type of valve (e.g., ON-OFF valves), not only control valves.

5.2 Expert Maintenance

This type of CBM combines conventional time-based maintenance with knowledge obtained through valve diagnostic analysis and offline analysis of returned valves, in order to achieve high value-added maintenance.

The top part of figure 14 shows the maintenance cycle usually used for shutdown maintenance. It is only after the valve is disassembled that the parts requiring repair are identified. As a result, depending on the severity of the problem and the availability of the repair parts, it may not be possible to complete repair within the shutdown maintenance period. Also, the checking of valves before shipment relies heavily on visual inspection, but this means that it is difficult to distinguish a preexisting problem from a problem arising after delivery, with the result that operation of the equipment may be delayed.

The bottom part of figure 14 illustrates the Expert Maintenance cycle recommended by Azbil Corporation:

1. Make a maintenance plan that is data-based by incorporating valve diagnostic analysis.
2. Obtain the necessary parts in advance by predicting which replacement parts are needed to prevent delays in the schedule.
3. Compare operating test results before and after disassembling the valve to ensure quality.
4. Check the valve diagnostic analysis results and the condition of the disassembled valve.
5. Hold a briefing session for the customer based on the check results.
6. Reconfirm the threshold settings for diagnostic indexes and the future plans for maintenance based on discussions in the briefing session.

By comparing the valve diagnostic analysis results based on data and the condition of the disassembled valve, the user can learn about the valve's characteristics. In this way the user can come to understand valve behavior during plant operation and prevent problems from occurring.

If the expert maintenance method is used, appropriate maintenance with high quality can be implemented. In the future, Azbil Corporation plans to continue developing diagnostic technology in order to provide high value-added condition-based maintenance using the expert maintenance method.

6. Conclusion

The control valve diagnostic application PLUG-IN Valstaff has been developed for compatibility with the enhanced diagnostic functions of the 700 series of smart valve positioners. Valstaff can diagnose the condition of control valves both while the plant is operating and when it is shut down, thus providing early detection of the symptoms of breakdown and deterioration. In addition, if the valve diagnostic analysis service, which is based on the analysis of data collected by Valstaff, is used, identifying maintenance targets and obtaining repair parts, etc., in advance is possible, resulting in improved maintenance performance.

Providing the functions and services that support condition-based maintenance mentioned above, Azbil Corporation strives not only to help customers implement appropriate maintenance, but also to ensure safety and peace of mind in plants and in society.

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