VALVE MONITORING ITI-MOVATS

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1.0 Introduction

Valve malfunctions cause unplanned plant downtime and can lengthen scheduled outages. This is the result of a preventive maintenance program where valve maintenance is scheduled according to a timetable instead of according to real needs. A PREDICTIVE maintenance approach, where degrading mechanical and electrical behavior is detected at an early stage, requires real-time data on the condition of the valve and the actuator.

ITI MOVATS provides a wide range of test devices to monitor the performance of valves : Motor Operated Gate or Globe Valve, Butterfly valve, Air operated Valve and Check valve. They were developed over a period of seven years to address the wide variations in actuator/valve design.

Major parameters measured are : Stem thrust, Torque for rotating stem and electrical actuator torque output, Motor power and current, Air pressure for pneumatic servomotor, ultrasonic and acoustic sensors for check valve.

Direct thrust measuring devices are used to monitor opening and/or closing valve stem thrust during various types of in-plant tests. Typically, the torque switch is set to achieve a predetermined stem thrust under static conditions. During differential pressure testing, these devices are used to measure the thrust required to overcome differential pressure, the stem rejection forces due to line pressure, the thrust at torque switch trip and the stem loads due to packing and sliding friction.

For electrical actuators, the spring pack methodology involves correlating spring pack displacement to stem thrust or actuator output torque. Once this correlation is established, spring pack displacement is used in conjunction with switch sensing to determine available thrust at control switch trip and thrust due to inertia after switch trip. Spring pack displacement is also used to measure differential pressure thrust and available thrust margin.

Motor power/load is used to trend actuator condition by detecting changes in actuator running load after maintenance and to identify degradations in the motor or between the motor and the spring pack. Motor current warn the test engineer of a locked-rotor condition in the actuator motor.

2.0 APPLICATION OF TEST DATA

ITI-MOVATS testing equipment is utilized in three related areas. For each test type, the collected data is utilized to meet specific objectives.

- Actuator setup/baseline testing
- Periodic/post-maintenance testing
- Differential pressure (DP) testing

2.1 Actuator setup/baseline testing objectives

Identify and correct actuator/valve degradations

a) Opening or closing stem thrust detect high running thrusts caused by packing over tightening or undersized upper bearing housing gaskets, deflect valve disc seating or unseating misalignment, loose stem nut lock nut and loose worm bearing lock nut.

b) Belleville washers or spring pack displacement measured is to evaluate the presence of specific abnormalities directly related to degradations in an electrical actuator or valve function as: Improper spring pack installation or function, misaligned valve guides, bent stem, incorrectly sized upper bearing gaskets, loose stem nut lock nut, and valve backseating.

c) Actuator output torque combined with stem thrust provides a direct measurement of the stem stem friction coefficient to evaluate the effectiveness of lubrication programs. The torque can be compared to spring pack displacement to evaluate degrading conditions between the spring pack and actuator output.

d) Motor power/current provides an indicator of a wide variety of degradations in the actuator as: Worn or broken gears, bent stems, changes in running load due to packing or valve friction coefficients, changes in running torque due to stem factor changes, and degradation of actuator lubrication,...

e) Limit and torque switch actuation points are used in conjunction with other parameters to identify certain MOV degradations related to the electrical circuits.

f) Actuator output torque and spring pack characteristics are measured and set using the Torque Test Stand and Packmate during refurbishment activities to diagnose actuator and spring pack condition.

Set Limit Switches

Switch sensing circuit data reflects specific limit switch actuation times. This data is used to document the stroke percentage of each switch trip. Thrust and/or spring pack traces are used in conjunction with switch sensing to ensure that the valve does not coast into the backseat after the open limit switch trips.

Set Torque Switches

a).The torque switch trip point is set to ensure that the actuator produces a specified amount of thrust in the open and close directions. The thrust can be measured by direct thrust measuring devices or using the spring pack methodology. To set the torque switch in the closing direction, a variety of direct thrust measuring devices are available.

b) Ensure that actuator thrust output does not exceed MOV limits. Total thrust is compared to actuator/valve stress limitations and thrust at torque switch trip is compared to calculated reduced voltage actuator output capability.

Document final settings and establish baseline for monitoring

a) After all maintenance is performed and MOV switches are set, baseline full stroke traces are acquired to document final configuration and to provide a basis for future comparison.

b) Baseline data used for comparison to periodic or post-maintenance tests consists of motor power or current. Periodic or post-maintenance measurements of motor power are compared to baseline values to identify changes may indicate a significant reduction in available thrust.

2.2 Periodic/Post-Maintenance testing objective

Periodic/post-maintenance testing is to identify changes caused by degradation with time or by maintenance activities. The most convenient way is to monitor motor electrical performance at the MCC and compare it to baseline information. By establishing conservative criteria, MCC testing can be used as a screening test to determine whether additional investigation is warranted.

2.3 DP testing objectives

a) Identify the thrust required to overcome dynamic conditions during differential pressure testing. Thrust and switch actuations are monitored and the maximum thrust due to DP is measured. This data may be included as part of a data base to predict thrust targets for other MOVs, or it may be used to estimate the requirements for the same valve at higher differential pressures.

b) If the test is at or near expected worst case conditions, identify the margin available between the thrust required to overcome DP and the thrust at which the torque switch trips (close direction). In addition to maximum thrust occurring due to DP, thrust at torque switch trip is identified. This margin represents the maximum amount that the available thrust of an MOV can decrease before operability is impaired.

c).Ensure that the open torque switch bypass covers dynamic unseating. Stem thrust and switch actuations are monitored during the open stroke. Valve cracking and unseating are verified to occur before the open torque switch is enabled.

3.0 Testing equipment

The parameters typically measured with the MOVATS diagnostics system and the devices used to measure them are described as follows :

3.1 Torque/Thrust: The "Torque/Thrust Cell" measures torque and thrust directly and simultaneously at exceptionally high accuracies. It allows the measurement of the operating efficiency of the power screw by determining the "stem factor". Easily mounted at the yoke-to-actuator interface due to a unique split design.

3.2 Stem Thrust: Stem thrust can be measured by stem-mounted devices that clamp on the solid or threaded portion of the stem and measure stem strain
Load cell mounted on top of the actuator is used to measure stem thrust in the opening direction. Either the stem or a stem extension makes contact with the load cell as the valve is operated in the open direction causing the torque switch to trip.
The Split-Nut Load Bar is a stem-mounted device that fits on the threaded part of the stem and uses load cells to stop stem travel in either direction used to measure stem thrust. It measures all of the thrust above running load, and since it stops valve motion, it measures thrust at torque switch trip and thrust due to inertia.

3.3 Spring Pack Displacement: Linear displacement of the Belleville washers or of the spring pack is measured by a device called the "Thrust Measuring Device" (TMD) using an LVDT or an optical encoder to measure displacement with a resolution of 0.025 millimeter.
Angular displacement of the torque switch is measured by a device called the "Torque Switch Transducer" (TST). This provides the same measure of spring pack displacement as the TMD.
External analysis of spring pack characteristics, force and deflection, is performed using the "Packmate". The device uses a load cell and LVDT to measure spring pack characteristics for comparison with design data.

3.4 Torque: Actuator torque is measured by an air brake system mounted on the bottom of the actuator that stops the actuator when sufficient air pressure is applied to the brake. A torque cell mounted between the actuator and the brake measures all of the torque above running torque. This test stand is mainly used for post refurbishment actuator setup. For Butterfly Valve, a load cell fixture is mounted on the top of the gearbox of 1/4-turn valves to stop the actuator and measure torque. The load cell(s) mount between a fixed and a moveable arm. All of the torque above running torque is measured.

3.5 Motor Power and Current: The "Digital Power Monitor" measures voltage on all three lines and current on two lines and converts them to a watts output.

3.6 Ultrasonic and acoustic detection: Disk position and stability is detected by use of ultrasonic flaw detection oscilloscope and associated non-intrusive ultrasonic transducers and accelerometers. A fast Fourier transform is performed and a frequency spectrum developed. Check valve malfunctions detected are : Free flutter of the disk, backstop tapping, Seat tapping, Missing or stuck disc, Hinge pin and disc/stud wear, Swing check/tilting disc, ...

3.7. Input/Output: The ITI-MOVATS Valve Analysis Systems are computer based systems. All the data collected and the results of the analysis are stored on electronic media like hard disk drive, floppies, tape, ... for quick retrieval. Relational databases are used to keep track of the valves/actuators parameters and of the testing results years after years for trending purpose. Friendly user menus, graphic features like zooming and overlay functions makes the utilization of the software easy and efficient.

4.0 Conclusion

WESTINGHOUSE and ITI-MOVATS have formed based on years of experience a comprehensive valve and actuator integrated program from design basis review to valve diagnostic, including: licensing support, Training, Equipment refurbishment, Procedure upgrades and spare parts supply. Integrated valve maintenance programs have been realized for many customers located in several major nuclear plants in Europe and in the U.S.A.
The equipment are adaptable to any type of actuators and valves. Up to now, actuators from Limitorque, Rotork, Auma, EMI, Siemens, Joucomatic have been tested by ITI-MOVATS.
Future development are focused on Smart software to assist the valve maintenance engineer in the diagnosis of the malfunction, and on an On-line system to allow continuous monitoring of the valve and actuator status.