New Raw Materials Improve Packing Sealing Efficiency

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ABSTRACT

End-users and OEM's using or manufacturing on/off and control valves expect a permanent and effective increase in service life together with an increased sealing capability while at the same time minimizing maintenance concerns. Developing materials which provide consistency and repeatability are essential characteristics to optimizing valve performance.

"New Generation" materials and yarn allow us to meet this growing demand while complying with the requirements related to chemical purity and an increased level of safety to both plant workers and equipment in the nuclear environment. Through R&D initiatives and developments in new and improved raw materials; a new mechanical packing generation which optimizes friction coefficients and extended life cycle has been introduced to the industry. Lower friction values drastically optimize actuator effort and size improving efficiency for stem operation with significant improvements in flow control of fluids. Combined with new and improved procedures (installation, torque levels and consolidation recommendations), this new packing generation has provided significant improvement in the mechanical behavior of packing materials (independent tests carried out in collaboration with AECL and CETIM) this has provided the opportunity to develop successful Valve Enhancement Programs which offer improved efficiency, valve operation and repeatability. These NEW generation yarns are available with or without wire reinforcement depending on specific operating parameters and conditions.

The purpose of this presentation is to demonstrate that new generation material(s). Which are available to the industry for AOV, MOV and Manual valves?

- To highlight the steps taken in R&D and manufacturing contributing to the much improved yarns and finished packing products.
- Comply and are designed to meet the stringent requirements in the nuclear industry
- Simplify valve maintenance without risk to safety or performance
- Increase service life of packing due to new yarn technology and improved manufacturing practices.
- Increase sealing efficiency of valves to develop consistent valve performance.
- Highlight the mechanical properties of New Generation materials when compared to conventional materials.
- Discuss the methodology behind new generation arterials and the specific applications where "added value" has been brought to the industry
- Supportive test data and sample material will be available upon request.

1. INTRODUCTION

Industry demand for improved valve performance and safety in conjunction with a commitment from some manufacturers of fluid sealing products has lead to the development of "NEW" generation valve packing materials. These developments being made possible through certain technological advancements in manufacturing and yarn development are making it possible to provide tomorrows solutions today.

As with many other products, fluid sealing products, for the purpose of this paper valve packing has become an integral component toward assuring a safer and more efficient operating system. Whether producing power or pulp, each industry benefits from these new products and developments. It remains essential that with the advent of new generation packing materials come the test results and qualification of such materials by independent laboratories capable of conducting such test programs.

In past years a small number of manufactures have focused on new technologies and the availability of new and improved raw materials for valve packing. For many years LATTY International has lead the way in developing new and enhanced products and SOLUTIONS for the nuclear industry. This on-going effort has lead to a number of new generation materials which provide the solutions to many of the valve packing and operability issues found in many of our stations.

The focus today, whether OEM or end-user is for improved valve performance through improved packing materials and solutions; valve sealing has taken a step into the next generation. This step forward requires the following: review of the functional parameters of valve packing; Tribology tests on existing and new yarns; a study to determine the influence of friction coefficients; a comparison of new and existing yarns; corrosion inhibiting properties; improved installation procedures and finally the added value to the end-user and valve manufacturer.

AREVA has entered into a business relationship with LATTY International in an effort to bring these new technologies and valve sealing solutions to the North American nuclear industry.

The Fluid Sealing and Valve Enhancement Program offered exclusively by AREVA are based and include new generation materials manufactured by LATTY International. Specifically developed for valve applications where low leakage and friction coefficients are essential to meet current industry and regulatory standards.

This paper will center and focus on those studies required to develop new valve packing products which can; comply with requirements set forth by the nuclear and petroleum industry, simplify valve maintenance while maintaining safety, increase service life of materials, increase sealing efficiency, valve performance and most critical can provide performance repeatability over the life of the plant. Various test results with respect to friction coefficients and the mechanical characteristics of graphite, graphite/PTFE and PTFE products will be introduced. Specific product test reports conducted on LATTY products by AECL laboratories, Chalk River will be made available to attendees by request. Additional test and approval information from Edf and CETIM laboratories will also be available upon request.

2. SIGNIFICANCE OF THE PACKING FUNCTION

One of the major concerns with respect to yarn development and new materials is protecting the quality of our environment. LATTY takes into consideration that in today's world we cannot measure valve leakage with only simple "bubble" detection. Todays technology to measure leakage is such that values <500ppm can be determined quickly and efficiently to determine fugitive emissions levels. Developing packing materials that can perform under stringent leakage regulations is a key component in the development process. Whether visible leakage or those detected through more sophisticated methods can be dangerous to individuals and equipment. Valve packing leakage can represent a HIGH cost with respect to regulatory, safety and production issues. In past years we have witnessed numerous changes to regulations guiding allowable leak rates in nuclear and fugitive emissions valve applications; in all cases minimizing the leakage to atmosphere level.

The function of valve stem packing can be summarized as a means to prevent leakage but also as an integral component in the overall performance and efficiency of a valve. Historically the function of valve stem packing has been leakage control. Technological advances in raw materials, yarn development and improvements to the manufacturing equipment and process now contribute to success of new generation materials. Many installation procedures have been revised to reflect the improvements and changes in materials, with those changes both and valve efficiency has increased. Proper packing installation done in accordance with effective packing procedures has proven to be an asset when attempting to increase packing life and overall performance of the valve. This procedure is in itself a topic for discussion and should be discussed but not within the content of this paper. Most manufacturers of fluid sealing products have recommended packing installation procedures, as does LATTY International/AREVA. It is advised that such be reviewed and incorporated into any existing station or plant procedure. The basic function of packing has transformed into a major component directly associated with valve and system efficiency. The most obvious example of this is the improved cycling of an Air Operated valve when newly developed packing materials are installed.

When faced with unnecessary applied stem friction the operation of the valve can be problematic and create system control issues. New generation valve packing materials manufactured by LATTY International and distributed by AREVA eliminate valve cycling issues, providing consistent ease of operation as a result of exceptionally low coefficients of friction. Reducing the coefficient of friction ultimately reduces the applied stem friction which in many cases could impact actuator design specifications by requiring smaller actuators. In cases where existing actuators are not reduced in size New generation packing materials can be installed to regain actuator margin and in many cases reduce historically high friction levels when compared to conventional materials. The importance of improved packing materials and the significance of their performance continue to be an integral part of valve operation, whether installed in Air Operated, Motor Operated, Manual or Actuated ON-OFF valves.

LATTY Next generation and engineered yarn and packing will provide the following characteristics and advantages:

- Decreased friction rate
- Improve the thermal resistance properties (temperature > 1110F/600C)
- Decrease the porosities
- Improve the calorific evacuation
- Preserve the packing materials chemical resistance
- Reduce leak rates when compared to conventional packing materials

In conjunction with proper installation procedures and devices such as VPMD's (Valve Packing Monitoring Devices) the new generation materials such as LATTYgraf 6745NG, LATTYgraf 6995NG, LATTYgraf 6940EF, LATTYgraf 6940 and LATTYflon 3265LM will provide the ultimate sealing solution while maintaining operational integrity.

Figure 1. Valve Packing Monitoring Device

Green – optimum load

Red- loss of load

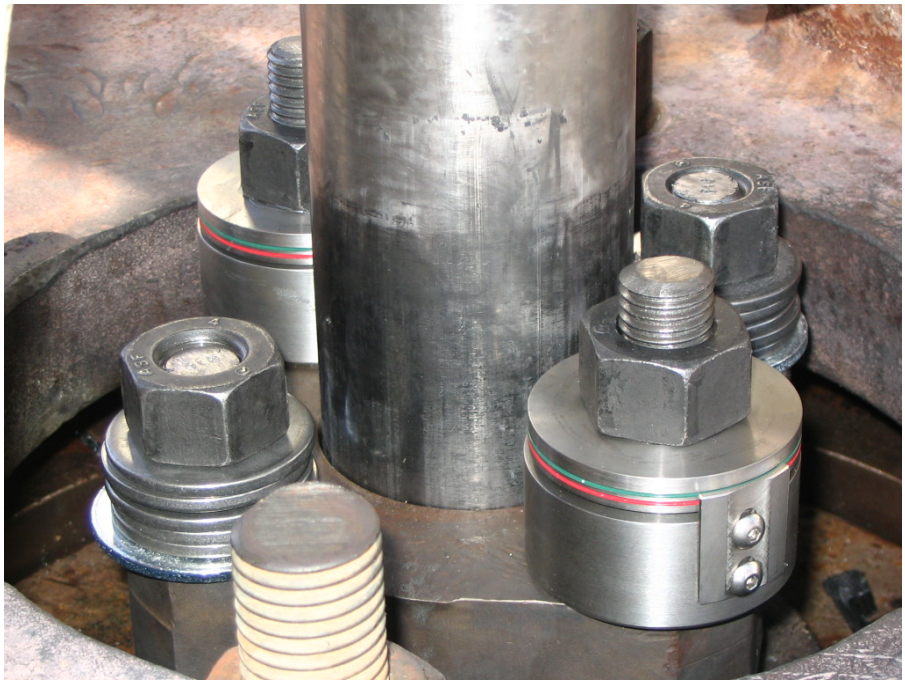

Figure 2. VPMD installation at Progress Energy

MSIV

Valve Packing Monitoring Device Benefits

- Visual confirmation of packing loss
- Monitors initial and in-service consolidation
- Engineered to existing and recommended gland loads
- Warning if re-torque is required prior to actual leakage
- Available for most all valve designs
- Recommended for HIGH cycled and CRITICAL valves

3. DEFINITION OF NEXT GENERATION VALVE PACKING MATERIALS

With the ever-changing requirements being placed on manufacturers of fluid sealing products for improved valve packing the R&D program at LATTY International is routinely developing new solutions. The many advances in technology with respect to manufacturing and yarn development have brought us into the next generation of materials. These advancements provide vast improvements in the mechanical properties of the finished product and are responsible for improved valve performance and operability. The new generation materials are those materials which through analysis and actual supportive test data have reduced friction coefficients; improved sealing capabilities; requires less gland adjustments; increased life cycle; minimizes valve stem and stuffing box corrosion; reduced leakage rates when compared to conventional

materials; reduced stem friction and consistency with repeatability. In addition new generation materials must be capable of meeting the stringent regulatory requirements of ISO 15848-1 while maintaining the acceptable chemistry levels for nuclear applications.

There are some manufacturers (LATTY International) which are committed to the development of new yarns and packing materials. This commitment and final result demands extensive R & D resources, but most critically the knowledge, capacity and desire to remain a leader in fluid sealing technology. It is clear many of the recent changes in permissible leakage levels, and limitations cannot be achieved with conventional yarns and materials.

In many cases, where regulatory and utility requirements have become more stringent we are left with few alternatives. Such requirements with respect to leak rates, and valve performance are anticipated to continue as technology improves. That continuance will remain the driving force behind the research and development among valve packing manufacturers such as LATTY International.

Industry demand for improved valve performance through enhanced valve packing materials can only be supported by extensive studies and subsequently independent qualification test programs. With the advent of new and improved materials, which meet the industry requirements comes another component of improved performance. Installation procedures in many cases must be revised to reflect the improvements made in next generation materials. These procedures for adequate material consolidation are paramount to realizing the benefits and success of new generation packing materials. Maximizing packing performance and valve operations will be optimized by simplifying and well defining packing installation procedures. In addition, supportive software programs to assist with configuration design and installation are an added benefit toward achieving optimal packing selection and performance. These packing software programs are available through manufactures such as LATTY International/AREVA and have been a successful asset to many valve packing programs.

For the purpose of this paper new generation packing materials are defined as yarns developed to meet specific performance requirements and leakage levels. Improved packing yarns have been developed through extensive research, supported be test programs that have evolved into the next era of valve packing materials. These materials, which have been through numerous tribology studies and independent performance testing, have demonstrated they can provide the solutions to today's harsh fluid sealing environments and diverse valve applications. Materials which at the onset considered the following as paramount to next generation materials:

- Friction Coefficient = Reduced
- Corrosion Levels = Reduced
- Measurable Leak Rates = Reduced
- Gland Adjustments = Reduced
- Stem Wear = Reduced
- Repeatability = Improved

New generation materials discussed are available for today's valve populations (End-User/OEM) for all industry. The products available today are the result of many years of research and development by LATTY international working jointly with valve manufacturers and independent test laboratories. Organizations such as AECL, CETIM and EDF have all contributed to the testing and qualification of many LATTY new generation valve packing materials.

4. TRIBOLOGY STUDIES

Extensive testing and studies to better understand the mechanical properties and behavior of various valve packing materials is essential toward developing the optimum product for the specific requirement. When organizing tribology and other studies LATTY considers the criteria for which the new generation packing material must meet. The approach is reasonably straightforward, such product must: comply with the requirements outlined by the petroleum and nuclear industry. Address the minimum leak rate requirements (ISO 15848-1) and contaminant levels set forth by nuclear regulators or utilities. Accomplishing the above requires and incorporates the study of friction, wear, lubrication, leak rates, improved lubrication, consolidation, packing stress, hysteresis, corrosion and stem wear.

Tribology studies and qualification testing will provide the information required to determine which material can simplify valve maintenance, increase service life of valve packing while increasing sealing efficiency and valve performance. Such studies and subsequent results can provide useful data which can be used to determine which material is best suited for a particular valve design; or system operating conditions and parameters.

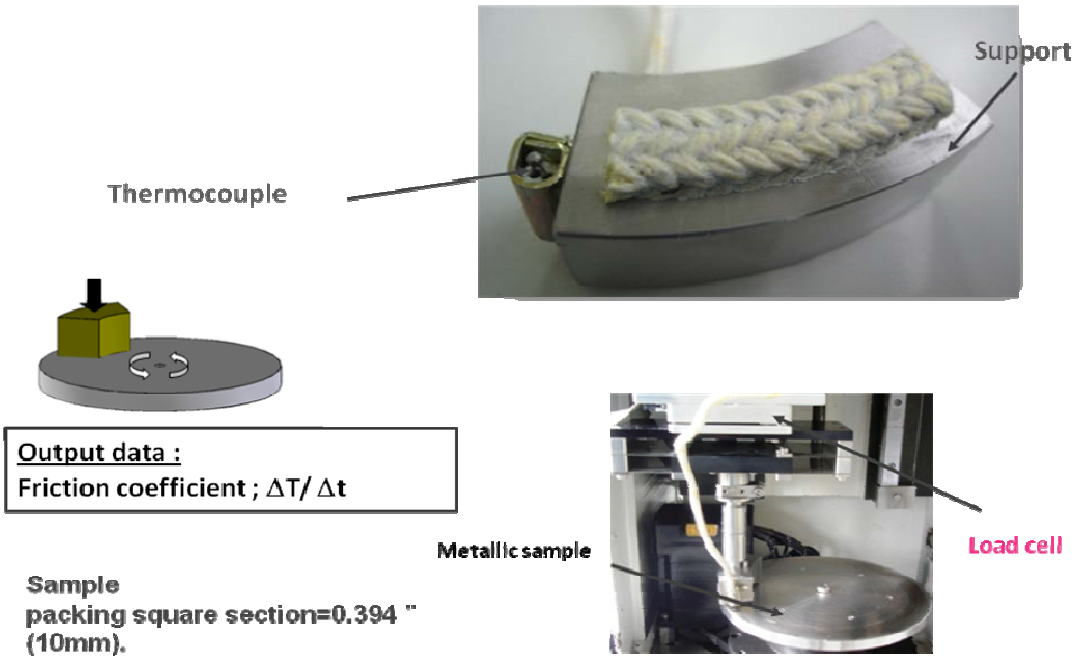

Figure 3. Room Temperature Tribology

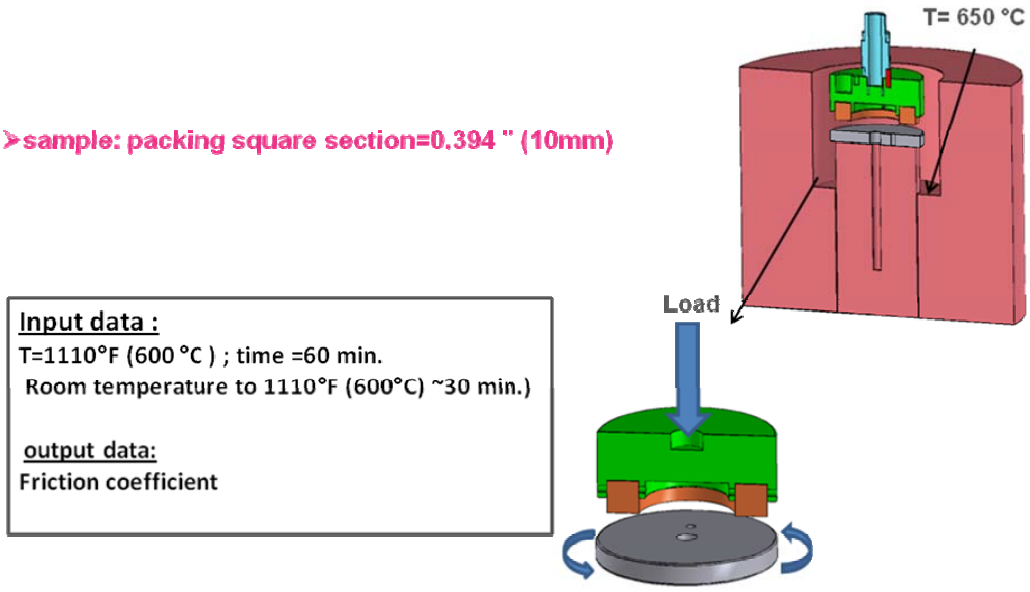

Figure 4. High Temperature Tribology

5. RESULTS – FRICTION / WEAR

Development of New Generation valve stem packing designed to address existing stem friction issues and valve operability begins with raw materials. Materials which initially have low coefficients of friction or can be enhanced by lubricity treatment processes such as the LATTY Filcoat process are candidates for New Generation materials. The relationship between materials providing low coefficients and the actual final applied stem friction are predictable and expected. There is a similar relationship between applied stem friction and gland load, increased gland loads equate to higher stem friction and decreased valve performance. Increased gland loads can increase stem friction and at the same time generate stem wear concerns on many stem materials. The graphic representations below highlight some comparisons between old generation and new generation materials; while demonstrating the relationship between load and friction.

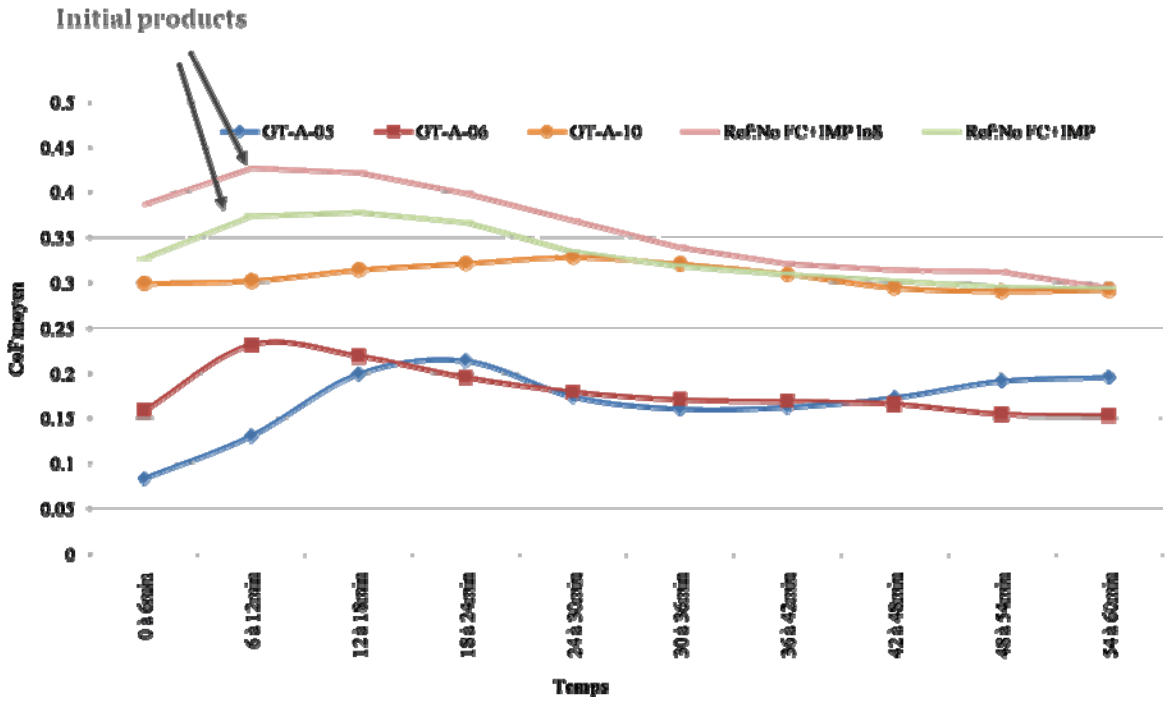

Figure 5. Top and Bottom Ring Results

Bottom (2) traces NEW Generation materials

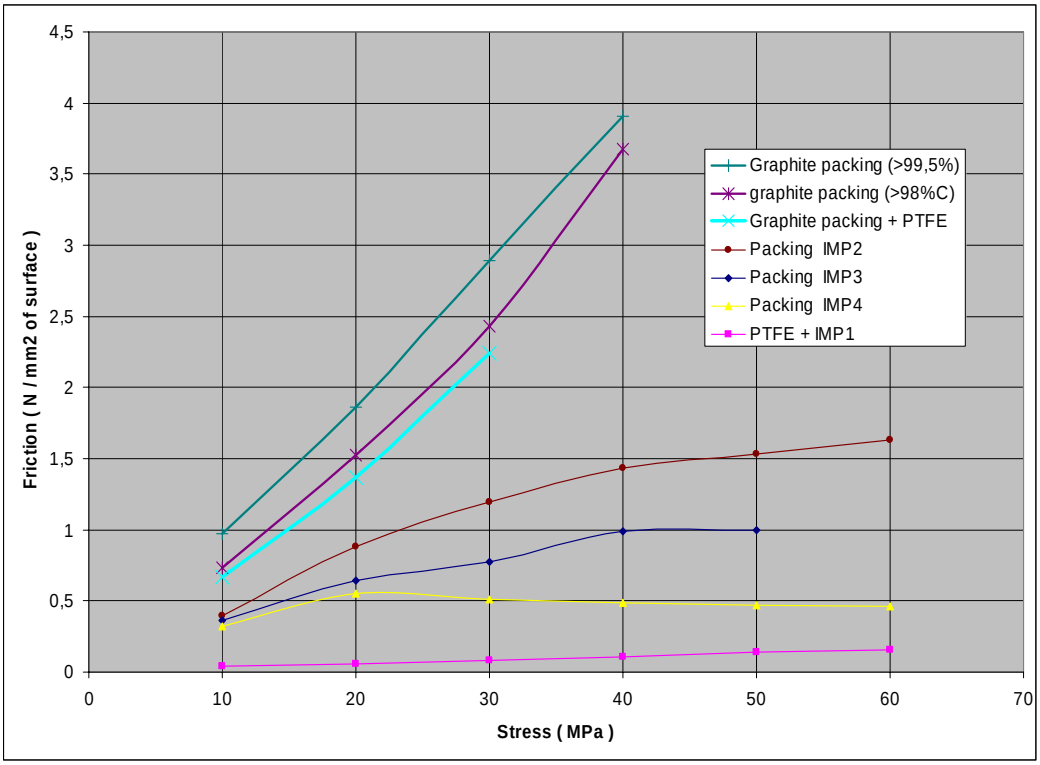

Figure 6. Friction Load Determination and Analysis Result

Bottom (4) traces NEW Generation materials

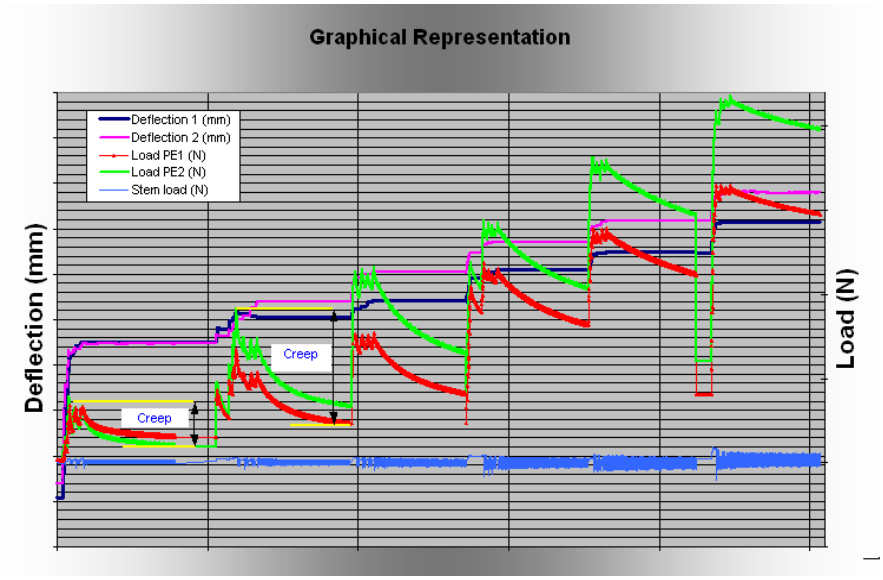

Figure 7. Typical Behavior of Packing Example #1

Load Stem (blue) - Stress Measurement (green/red) – Deflection (d.blue/pink)

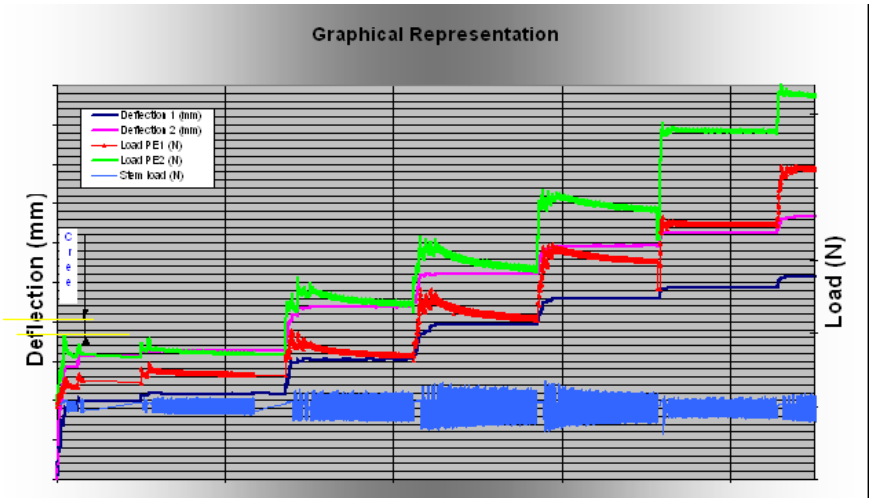

Figure 8. Typical Behavior of Packing Example #2

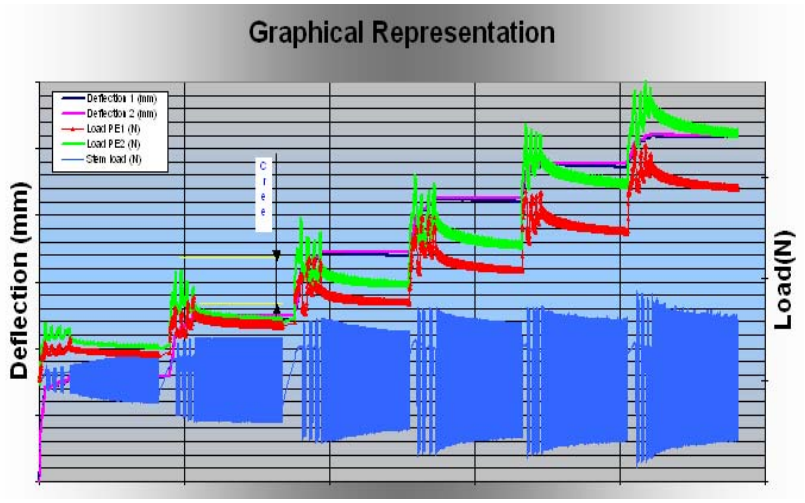

Figure 9. Typical Behavior of Packing Example #3

Figure 10. Friction Load Determination and Analysis

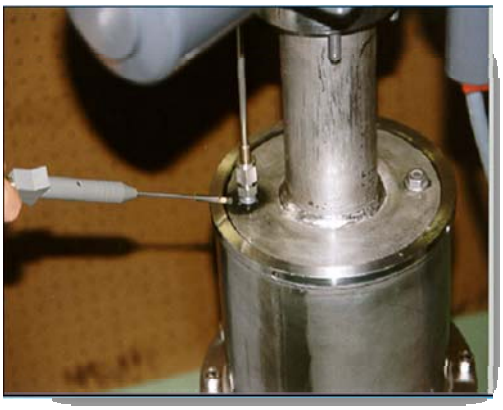

Figure 11. Leakage Measurement

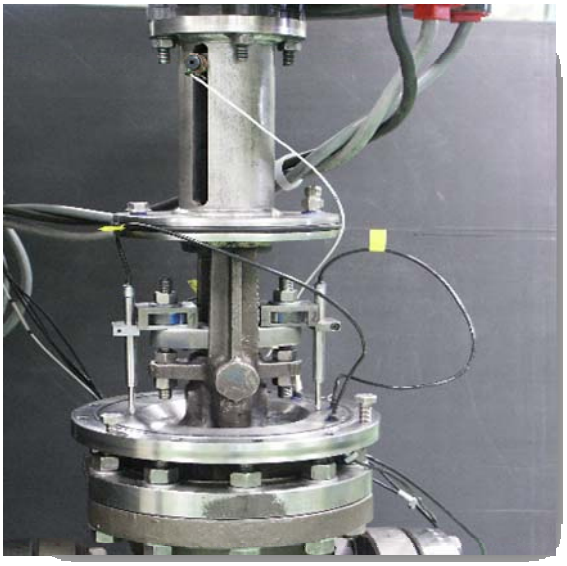

Figure 12. Load Stem Measurement

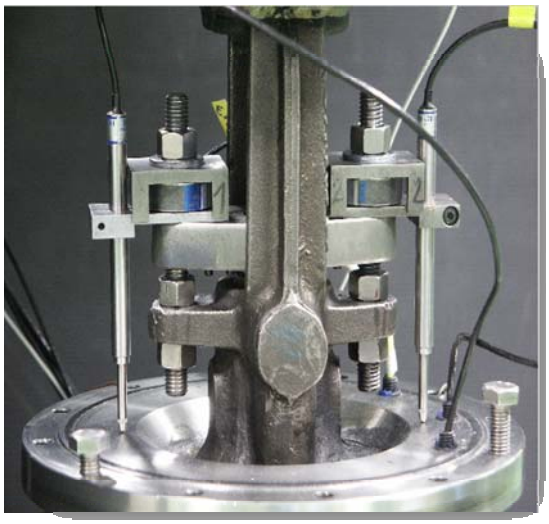

Figure 13. Stress Packing and Deflection Measurement

6. RESULTS – CORROSION

A key element in the efficiency and life cycle of valve stem packing is the packing materials ability to prevent corrosion of the valve stem and stuffing box. The types available (2) are referenced as a passive or active inhibitor. Through extensive testing and research it has been determined by LATTY International and others that passive inhibitors are more effective by separating the electrical contact between two dissimilar metals. The metals are protected by building a film type protective coating on the stem. The option of an active inhibitor is used frequently in packing and operates on the premise of a sacrificial anode (zinc) being consumed over time. This method although widely used is becoming less popular due to studies which reveal the corrosion protection was lost in 30-45 days in some cases. Without corrosion inhibitors the valve stem will become the anode where pitting and corrosion will quickly occur. Generally galvanic corrosion will be encountered when a valve is packed with a carbon or graphite packing set at high temperature.

Extensive tests indicate the optimum corrosion inhibitor which will provide unlimited and complete protection to the valve stem is that of a passive inhibitor, used exclusively by LATTY International

3.2 Fixture

The test fixture is presented here. Before each test, all the components of this fixture are cleaned in an acetone bath with ultrasonic.

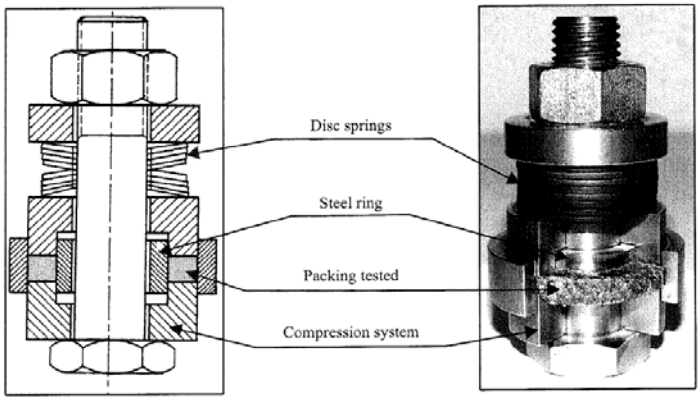

Figure 14. Test Fixture Example

Figure 15. Z30 C13 Corrosion Example

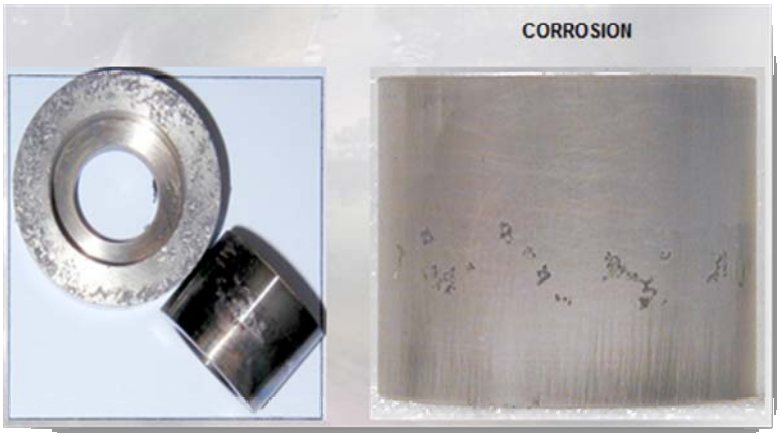

Figure 16. Z12 C13 Corrosion Example

Figure 17. Z30 C13 Corrosion Comparison

7. LEAKAGE-FRICTION

*__AECL__ Test and Qualification Report Available Upon Request (LATTYgraf 6745**NG**)

8. LATTY PRODUCT SUMMARY

Valve packing products listed below are those which have been developed to address the concerns contained in this paper and improve overall valve performance and packing life cycle:

LATTY*graf* 6745NG	AOV/MOV/Manual	AECL Tested and **Approved**
LATTY*graf* 6940	Low cycle/Manual/On-Off	AECL Tested and **Approved**
LATTY*graf* 6940EF	AOV/MOV/Control	AECL Tested and **Approved**
LATTY*graf* E1	HT and Pressure/ Manual/On-Off	AECL Tested and **Approved**
LATTY*flon* 3260LM	Control Valves	AECL Tested and **Approved**

9. CONCLUSION

Today, industry in general will benefit from new technology, tests, studies and improved yarn development which provide a more detailed and concise understanding of fluid sealing products. Tribology studies demonstrate the improved mechanical properties and characteristics of New Generation packing with respect to reduced friction coefficients. These materials can contribute to energy savings, smaller actuators and improved safety. Applying the data acquired supports the position that upgrading ones sealing characteristics and performance will improve valve performance, repeatability and dependability. When applying this information to the design or end-user maintenance level we can expect an improved and more efficient sealing solution for the specific valve design; at the same time evaluating the mechanical behavior and tightness of the components. This capability permits a determination as to whether the materials and configurations provide the solution required by end-user.

Valve packing efficiency and its service life are key elements that remain driven by:

- The stuffing box and stem conditions prior to installation
- The quality and integrity of the packing material
- Proper installation of the packing material with respect to the valve design.
- Adequate and effective gland loading of the packing using recommended procedures
- Implementing an effective procedure for packing CONSOLIDATION during the installation process.

The continued efforts by LATTY International and others to develop improved materials and methods continues with products such as LATTYflon 3265LM and others which provide the added security and performance characteristics expected by both valve manufacturers and end-users.

New generation materials will contribute to the success and improvement of today's valve packing programs BUT not to be considered the only item of importance. Those items mentioned above make it possible for companies such as AREVA and LATTY International to offer improved sealing. That in combination with a philosophy to be a provider of solutions not simply products adds to the success of AREVA's **Valve Enhancement Program.** For additional

information pertaining to New Generation materials and the Valve Enhancement Program please visit the AREVA booth where **AECL** Test and Qualification Reports will be available upon request.

ACKNOWLEDGMENTS

The author respectfully acknowledges the effort and information provided by the Research and Development Group of LATTY International. Test data and information provided by AECL, CETIM and the EDF research laboratories.

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