Wear, Wall Friction Tests Support TIVAR® 88 Flow Promotion Claims

BACKGROUND

Handling bulk solids that do not flow reliably or uniformly through bins, silos and chutes can be costly for companies that have processes requiring continuous feed rates. Problems occurring in gravity feed operations such as erratic flow, no flow, bridging and ratholing are common throughout the bulk solids handling industry. These problems result in lost production, increased manpower and poor quality control.

In an effort to understand precisely how TIVAR® 88 enhances solids flow, Poly Hi Solidur commissioned Jenike & Johanson, Inc., to test TIVAR® 88 with respect to wear properties and coefficient of friction (wall friction).

In the past, TIVAR® 88 has proven through field experience to be a cost-effective wall surface lining that provides consistent flow of solids. Due to its low wall friction and superior sliding abrasion resistance, TIVAR® 88 has been specified by prominent engineering firms as the primary sliding wear surface in new and existing bulk solids handling systems.

TIVAR® 88 has been specified as the primary sliding wear surface in the industry because it promotes mass flow, a flow pattern in which all material in a bin or silo moves when any material is withdrawn. Mass flow eliminates dead regions within a bin and a material's tendency to rathole.

In funnel flow bins, material does not flow along the wall until the bin is emptied. This can give the hopper wall time to corrode, encouraging material to adhere to the wall. TIVAR® 88 has excellent corrosion resistance and non-stick characteristics that provide better clean-out.

Now, information has been developed for TIVAR® 88 supporting both wear resistance and wall friction, using recognized testing procedures.

WALL FRICTION

Wall friction is the resistance that occurs when a bin's substrate opposes the relative motion of a bulk solid sliding along its surface. Wall friction data can be used to anticipate the type of flow that will occur inside a bin and enables calculation of bin loads. Prior to designing or retrofitting a bin, silo or chute, wall friction should be considered.

TIVAR® 88 has an exceptionally low sliding friction angle when compared to stainless steel and carbon steel (Fig. 1). The low sliding friction angles associated with TIVAR® 88 translate into lower construction costs by building more efficiently designed bins with shallower hopper angles.

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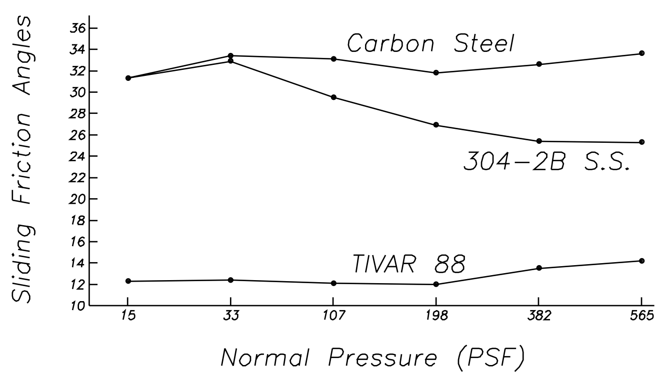

Figure 1: The sub-bituminous coal for this test came from the Powder River Basin in Wyoming. Data is presented for information purposes only and is not intended to be used for design criteria.

WEAR DATA

The associated graphs show results of tests performed by Jenike & Johanson, Inc., with their wear test apparatus (US Patent 4,446,717).[2]

Three coal samples were tested on surfaces at various pressures and velocities. The bituminous coal was a hard, sharp and relatively abrasive type from Pennsylvania. The sub-bituminous came from the Powder River Basin in Wyoming. The lignite was a soft, cohesive coal from North Dakota.

Wear rates shown in Fig. 2 were used to calculate the predicted wear life of TIVAR® 88 and 304-2B stainless steel. The highest wear rate for TIVAR® 88 with the bituminous coal is about 0.028 in/year at the outlet. A 1/2"-thick TIVAR® 88 liner would be useful for about 17 years at this rate. With the lignite coal, a 1/2"-thick liner would have a projected life of more than 100 years. The wear life was based on a 25ft. diameter circular bin with a conical mass flow hopper converging to a 2ft.-diameter outlet.

It is assumed the coal has a bulk density of 50lbs./ft.[3] being withdrawn at 50 tons/hr. An illustration of the bin and the calculated solids pressure and velocity profiles are shown in Fig. 3. Here, the solids velocity shown is the wall velocity calculated in accordance with the formulas given in the papers referenced below.

Wear rates are higher near the outlet because of the higher velocity, although even at the highest wear rate for TIVAR® 88 with bituminous coal, it is still considered to be an excellent liner option. It is possible to use thicker liners near the outlet in order to achieve a more uniform wear life throughout the hopper section.

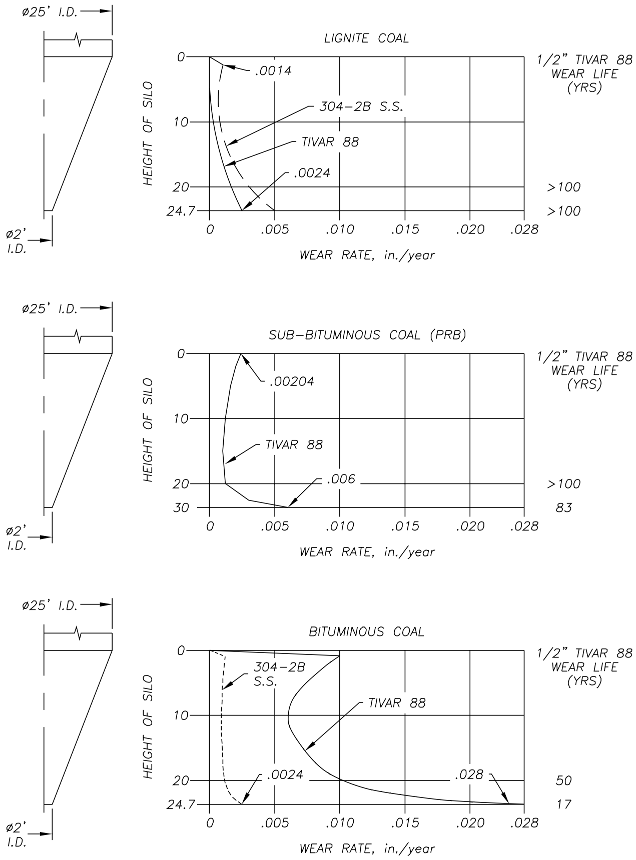

Figure 2: Wear rates in a mass flow hopper based on 24-hour operation 365 days per year.

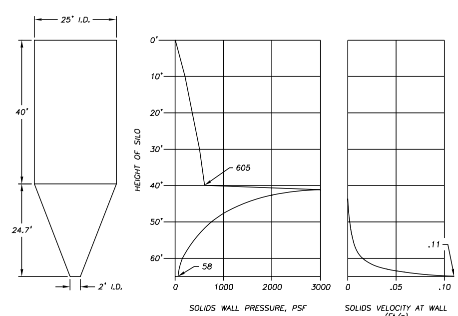

Figure 3: Pressure and velocity graph for a 25' dia. silo designed for mass flow handling coal with a bulk density of 50lbs/ft[3] and being discharged at 50 TPH.

REFERENCES

[1] Jenike & Johanson, Inc., One Technology Park Drive, Westford, MA 01886, USA, tele: 978-392-0300, fax: 978-392-9980.

[2] Johanson, J.R. and Royal, T.A., “Measuring and Use of Wear Properties for Predicting Life of Bulk Materials Handling Equipment,” bulk solids handling, Vol. 2, No. 3, Sept. 1982, pp. 517-523.