RECOMMENDED THREAD COMPOUND APPLICATION PROCEDURES FOR LONG-TERM STORAGE

The following is Bestolife's recommendations for the application and use of our thread compounds when applied to tubulars prior to long term storage:

1. Control of Process Conditions:

⇒ There are a variety of process conditions that accelerate the corrosion and pitting of threaded surfaces. They include:

- Composition and type of cutting fluids and hydrostatic test fluids
- Contaminants such as chlorides and sulfides in process fluids
- pH of process fluids
- Bacterial growth in process fluids

These factors must be addressed, monitored, and controlled or no post process treatment for long-term storage will be totally effective.

2. Thread Surface Preparation and Contamination:

⇒ Connection surfaces should be free of moisture and contaminants prior to the application of any compound, whether it is intended for storage only or also as a "running" compound. All corrosion effects are the result of an electrolytic process that requires both water and dissolved ions (chlorides, sulfides, sulfates, and other dissolved ions) to serve together as an electrolyte. Most corrosion inhibitors are "surface active", meaning that these active molecules will attach themselves to the metal surfaces preventing access by the contaminants that cause corrosion. If those contaminants are present on the threaded surface prior to application of the thread/storage compound, they will be trapped against the surface and corrosion will occur. Simply drying the surface with compressed air will not be sufficient. When the moisture evaporates, any dissolved contaminants will remain on the surface. To remove moisture and contaminants, a dewatering fluid/corrosion inhibitor can be applied to threaded surfaces. Immediately prior to compound application, any excess dewatering fluid/corrosion inhibitor on threaded surfaces should be removed.

3. Compound Application:

⇒ The primary difference in the functional properties of storage-only compounds and compounds with storage capabilities (hybrid compounds) is in one of their physical properties, viscosity. Storage compounds are more fluid than running compounds and as a result, the method of application used is not a critical factor. When applied, storage compounds flow readily around the thread surface and when a thread protector is installed, they flow easily between the clearances. Running compounds, however, are fairly stiff and contain a high volume of solid materials. Care must be taken to apply a uniform coating over a threaded surface. Also, when the compound is applied to the pin end and the protector is installed, the protector will push the compound away from the pin nose and in most cases will leave voids that will

(continued)

allow moisture to enter between the protector and the threaded surface. In order to assure that there is a even distribution of running compound under the protector and that voids near the pin end are eliminated, it is recommended that a small amount of compound be applied to the inside of the pin protector prior to installation. This will cause compound to be forced both directions inside the protector as it is being installed. Ideally, there should be a small amount of excess compound extruded from both ends of the protector, the pin nose and at the base of the threads. This excess material will seal off the protector from ambient moisture, preventing water from entering and becoming trapped between the protector and the threaded surface. If thread compound and screw-on test caps are used for hydrostatic testing, the compound that is contaminated with the hydrostatic test fluid must be removed and the thread surfaces cleaned, as described above, prior to the final application of any storage or hybrid compound.

4. Thread Protectors:

⇒ Thread protector material and design can have a significant influence on the incidence of pitting and corrosion in long-term storage. One major drawback to the metal protectors, that were widely used more than ten to fifteen years ago, was that they would promote corrosion if there was moisture under the protector because the composition of the protector metal was different from the metal of the pipe body. Metals in contact that have different composition cause a difference in electrolytic potential that accelerates the corrosion process. Most protectors currently being used are either all plastic or plastic/metal composites. These types of protectors prevent dissimilar metals from coming in contact and resulting electrical potential problems. However, these protector types have no control over expansion or contraction due to changes in ambient temperatures. The difference in the thermal coefficient of expansion between plastic and steel is significant. Plastics commonly used in protectors, such as polyethylene, polypropylene, and polyurethane can have a thermal coefficient, as much as 10 times that of steel. Even in composite protectors, the difference can be substantial. During the normal daily temperature cycle that pipe in storage is routinely exposed to, the temperature of the pipe body can fluctuate by more than 75°F (42°C). This temperatu re cycling results in a "pumping" action when the protector expands and then contracts at a much greater rate than the steel pipe body. If there is any moisture present due to rainfall or condensation in contact with the protector/pipe interface without a positive seal (either by mechanical means or excess compound), then that moisture will work its way under the protector and eventually promote corrosion regardless of which compound is applied.

Another factor in thread protector design is the clearances between the protector and the pipe threads. The clearances must be large enough to allow the compound to distribute evenly over the contact surface without wiping off or removing the compound as the protector is installed. But at the same time, there must be a positive seal either supplied by the compound or the protector to prevent moisture from getting between the protector and the pipe surface. Elimination of moisture between contacting surfaces is of primary importance since this moisture can cause "crevice" corrosion. If materials that promote corrosion (water, contaminants, and other ions) are confined between two surfaces in tight contact (crevice) the reaction products generated will not be able to dissipate and will increase the ion concentration (contaminants) in the electrolyte (water) and greatly accelerate the corrosion process.