Scibond SL-23
Polymeric Lubrication System for Tube Drawing

I. Introduction:

Scibond SL-23 is a novel water-based a polymeric lubrication system. It was developed under National Science Foundation grant number 0620290 in conjunction with the Mechanical and Aeronautical Engineering Department at North Carolina State University as an environmentally friendly alternative to the zinc phosphate system. It has found utility in tube drawing for carbon, chromium and stainless steel tubes. Preparation of the tubes varies depending on the metal. In addition to the elimination of hazardous waste materials, the system results in a significant reduction of energy usage, dust generation in the workplace, and saves wear on dies and mandrels.

By following these guidelines, we have been able to draw at increased speeds with improved quality and consistency.

II. Carbon Tubes:

The preparation for drawing carbon steel is extensive due to the rust and scale formed on the tube surface, roughness of the surface, and generally thicker walls. When using the zinc phosphate system, the tubes undergo a series of degreasing and acid washing to remove the rust and scale called pickling. This step is still recommended for the polymeric lubricant. Once the tube is cleaned, it is immersed in an iron phosphate "conditioner" bath. The need for a neutralizer is eliminated. The tubes are then cold water rinsed, immersed into the polymer bath, and dried.

A. Iron Phosphate Pre-coat

Studies have shown that the use of an Iron Phosphate pre-coat enhances the performance of the polymeric lubricant. It is now believed that the iron phosphate layer acts as a tie coat between the metal surface and the polymer coating. It is necessary to minimize the thickness of this coating to allow the polymer lubricant to bond to the pipe surface. If the iron phosphate impedes the adhesion of the polymer to the metal, then the lubricant will be "snowplowed" off of the tube when passing through the die and be ineffective. We have seen that a nonionic stabilized iron phosphate such as that supplied by Henkel will provide a sufficiently thin coating to be effective. To accomplish the desired coating, the acid level of the phosphate is monitored, and is allowed to increase very slowly over time, starting initially at about 18-19 points, and not to exceed 25 to 28 points over time. A continuous slow feed may provide the most consistent performance. If, over the course of several months, soluble components build up in the conditioner tank, it may inhibit the drying of the polymer. The iron phosphate can safely be discharged into the waste water system, and the tank re-charged with fresh material.

The phosphate is applied as an exhaust bath, and requires heat to activate it. It is recommended that the bath be kept at 165^{o}F to 175^{o}F. No agitation is required, so it can be used in tanks that are currently used for the zinc phosphate. The application process to insure a uniform coating involves dipping the tubes into the solution three times at a residence time of two minutes each. Between immersions, the tubes are drained and then re-immersed alternating the ends that are first introduced. After the final immersion, the tubes are drained from the open end.

After the application of the iron phosphate, it is recommended that the tubes are rinsed in cold water prior to being dipped into the Scibond SL-23. Again, this rinse bath contains no hazardous materials and can be safely discarded into the local water system. This bath can either have a continuous over-flow, or be changed on a specified basis.

B. Scibond SL-23

Scibond SL-23 is an emulsion polymer supplied at 34-35% solids content. In use, it is recommended that the solids be reduced to 17-19% by the addition of water. A simple test in which a small sample of the polymer is weighed, dried, and reweighed, and then the ratio is calculated provides the percent solids of the bath, and can be performed once a day or whenever a fresh charge of polymer/water is made. With-in limits, local water can be used to dilute the polymer. At one location, the water was pulled from a local lake with no pre-treatment, and was successfully used. Consideration must be given to the level of electrolytes in the water, as it may reduce the stability of the product.

Scibond SL-23 is an acrylic emulsion, and can be compared to a water-based paint. It provides a coating to the metal surface, rather that reacting with it from a reactive bath like the zinc phosphate. Therefore, the concentration of polymer in the bath remains constant, and polymer is only added to replace the material taken out by coating the tubes. As a result, once the initial tank charge is made, re-charging the tank is unnecessary, and product consumption is greatly reduced compared to zinc phosphate. Most significantly, this system totally eliminates all waste streams, hazardous or not.

Like paint, SL-23 can be applied at room temperature, and has a fairly broad temperature tolerance. It is recommended that the pH be maintained in the range of 8.8 to 9.5 to maintain emulsion stability. This is accomplished by sub-surface charging of ammonium hydroxide, which minimizes odor. A daily check of the pH is sufficient for consistent performance.

The surface of the polymer tank should be kept moving to prevent a skin from forming, and depositing an excessive amount of polymer onto the pipes. The tank should have an overflowing weir and recirculating pump, which is the common set-up for the reactive soap in the zinc phosphate system. Thus, this system is a direct drop-in for the zinc phosphate system.

Again, for a uniform coating we have seen that multiple immersions provide the best results. In this case, the polymer needs only to wet the surface; so three immersions of one minute each were used, with the final drain being towards the open end of the tube. The final draining should be sufficient to minimize drag-out, as too much polymer on the surface will be difficult to dry.

C. Drying

Drying of the polymer is critical in obtaining good lubrication. The polymer must be able to adhere to the metal surface to provide good lubrication, otherwise, when the tube is drawn, the polymer will simply be wiped off of the tube during the draw. In the wet state, the polymer is a milky white, which then dries clear. Forced hot air drying is necessary to minimize the drying time.

Any number of drying configurations can be used, and the effectiveness of the dryer will determine the dry time. The temperature range can vary since the polymer will tolerate a wide range, however a minimum temperature of 180^{o}F will be most effective. The critical points to be dried are the inside diameter of the tube, and the points on the outside diameter where adjacent tubes come in contact with each other. Sufficient airflow is needed to dry the inside diameter, and the contact points on the outside are areas with higher levels of polymer due to capillary forces.

III. Chromium and Stainless Steel

The preparation of chromium and stainless steel is simplified, since the surfaces are generally free of rust, and the tube walls are thinner than carbon steel. The surfaces should be free of oils that can inhibit the wetting of the surface by the water-based polymer. If oil is used for the pointing process, the tubes must be degreased before immersion into the polymer. An alternative is to immerse the tubes into the polymer first, and use it as the pointing lubricant as well as the drawing lube.

Appendix 1
Test Procedures

I. Test for Acid Content in Conditioner 66 RN

II. Title: PERCENT SOLIDS (NONVOLATILES) BY FORCE DRAFT OVEN

Policy: This method will be used to check solids

Purpose: Check percent solids of product.

Scope: To determine percent solids of products.

1.0 Procedure

1.1 Preheat the oven to 140±2°C. Confirm oven temperature on thermometer in oven.

1.2 If sample being tested is a base, temperature of sample must be adjusted to <30°C before weighing out. All final samples should come to the lab within this temperature range, however, if final is >30°C then the temperature will be adjusted.

1.3 Check the bubble on the Analytical Balance and adjust if necessary.

1.4 Wash your hands to remove any skin oils, body lotions or powders that might transfer to the aluminum weighing dishes. Dry hands thoroughly before handling dishes.

1.5 Score or mark two aluminum dishes for each lot number to be tested.

1.6 Accurately weigh (to the nearest 0.0001 gram) each aluminum dish. Record this empty weight as the “tare” weight.

1.7 Place approximately 1 to 1.5 grams of emulsion into each dish. Spread the emulsion evenly over the entire bottom surface of the dish. Record as the net weight to the nearest 0.0001 gram.

1.8 Place the samples in the oven.

1.9 Set the timer for 30±1.0 minutes. Start the timer when the oven recovers to 140± 2°C.

1.10 When 30±1.0 minutes have expired, remove the dishes from the oven.

1.11 When cool the touch, weigh and record the gross dry weight of each dish. (Gross dry weight) Do not allow tins to sit for more than 5 minutes before weighting back. Tins will begin to gain weight.

1.12 Calculate the solids for each sample dish using the following formula:

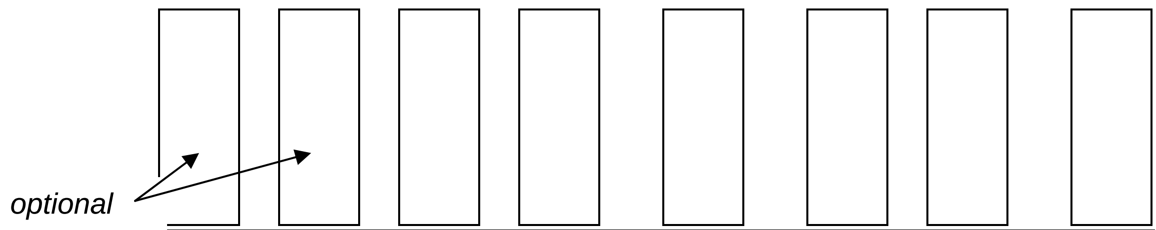
% Solids Content = (Gross "Dry" Weight – Tare)(÷ Net Weight) X 100

The duplicates must agree within 0.5 of each other, if not then you much check samples over. Example: 50.21 - 50.51 = 0.30 acceptable. 50.21 – 50.81 = 0.60 not acceptable must repeat.

1.13 The test results for both samples from each lot number are added together and divided by two. This average is recorded as the Percent Solids of that lot.

Appendix 2
Process Summaries

I. Carbon Steel:



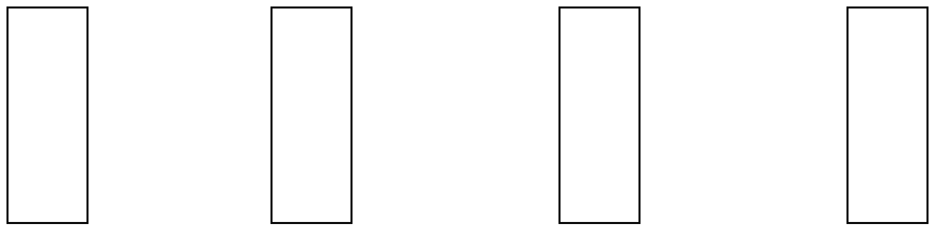
1	2	3	4	5	6	7	8
Alkaline clean	Hot water rinse	Sulfuric acid pickle	Cold water rinse	Iron Phosphate	Cold water Rinse	Polymer Scibond SL-23	Forced hot air dry
8 min	2 min	10 min	2 min	6 min	2 min	3 min	
190^{o}F	175^{o}F	150^{o}F	Room temp.	165^{o}F-175^{o}F	Room Temp..	Room Temp.	

- Pickle as before
- Cold-water rinse after Sulfuric acid. No neutralizer needed.
- Conditioner 66 RN

    Temperature 165^{o}F to 175^{o}F
    Points 18-19 initially up to 25 to 28 over time
    Non-recirculating tank (zinc phosphate tank)
    Immerse 3 times at 2 minutes each. Final drain to open end of tube
- Cold-water rinse, either overflow or change on regular basis
- Scibond SL-23

    Room temperature
    % solids at 17-19%
    pH maintained at 8.8 to 9.5
    Tank with overflow weir and recirculating pump (reactive soap tank)
    Immerse 3 times for one minute each. Drain to open end.
    Minimize drag-out
- Drying sufficient to produce clear film

II. **Stainless Steel**



1	2	3	4
Alkaline clean	Hot water rinse	Scibond SL-23	Drying
8 minutes	2 minutes	3 minutes	
190^{o}F	175^{o}F	Room Temp.	

- Alkaline clean and hot water rinse optional
- Scibond SL-23
  Room temperature
  % solids at 17-19%
  pH maintained at 8.8 to 9.5
  Tank with overflow weir and recirculating pump (reactive soap tank)
  Immerse 3 times for one minute each. Drain to open end.
  Minimize drag-out
- Dry to clear film

Contact Information

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