

Hydraulic systems play an increasingly critical role in manufacturing today. Systems that are engineered and fabricated correctly enable the manufacturing process to increase both quality and reliability of the products produced. These increase productivity and make it profitable and efficient to operate in a “Just In Time” mode. J.I.T. is only possible when every part of the entire system is working properly. To be assured of this capability requires that your system be designed so that the damaging metallic debris that destroyed systems in the past is not present in your new one.

Modern hydraulic systems operate at greater pressure and have precision and accuracy which were not available in systems even 10 years ago. To achieve this, today’s valves and pumps are manufactured with closer tolerances—which make the components more susceptible to damage from debris in the system. This fact has caused standard writing bodies (such as A.S.T.M., S.A.E., and I.S.O.) to address specifically the issue of component and system cleanliness in order to stem the otherwise inevitable rise of catastrophic system failures.

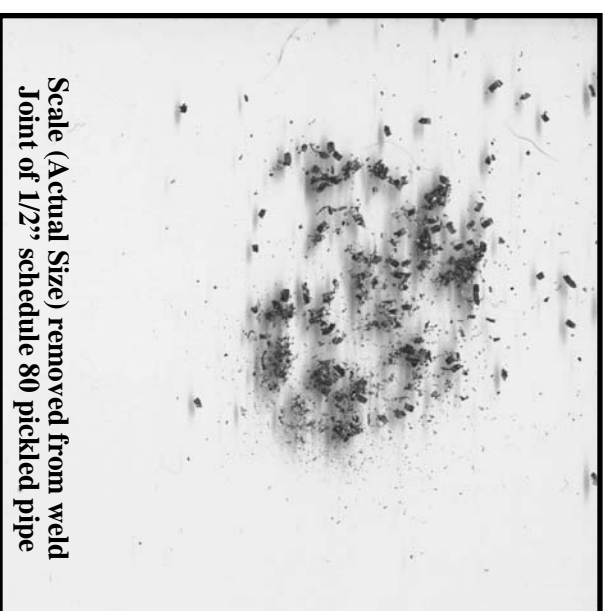
The Standards they have developed, when followed, produce a system which truly utilized the full potential of today’s components.

REDOX SERIES 81 pipes and fitting are cleaned with strict adherence to these Standards. Their quality assures that you get the most from your hydraulic system without problems such as hydrogen embrittlement, intergranular corrosion, and gross contamination. The results of what occur on the I.D. of the pipe can best be seen when comparing Figure 1 vs Figure 2.

Many of the topics discussed in this brochure are supplemented by **REDOX** Tech Sheets which provide additional technical information. You will find that the tech sheets include useful engineering and fabrication information that will enable you to specify clearly whatever your hydraulic system requires on prints and specifications. **REDOX** is committed to offering you the best hydraulic pipe and fittings, as well as the technical information, necessary to realize the full potential of your system.

DYNAMIC CLEARANCES

In the past, piston pumps and servo valves were protected by using high quality filters to guard them against the contamination that was present in the systems. The common belief was that unusually close tolerances made these components susceptible to contamination failure. Now, as you can see in Figure 3, most hydraulic components have similarly close



Scale (Actual Size) removed from weld joint of 1/2" schedule 80 pickled pipe

Figure 1

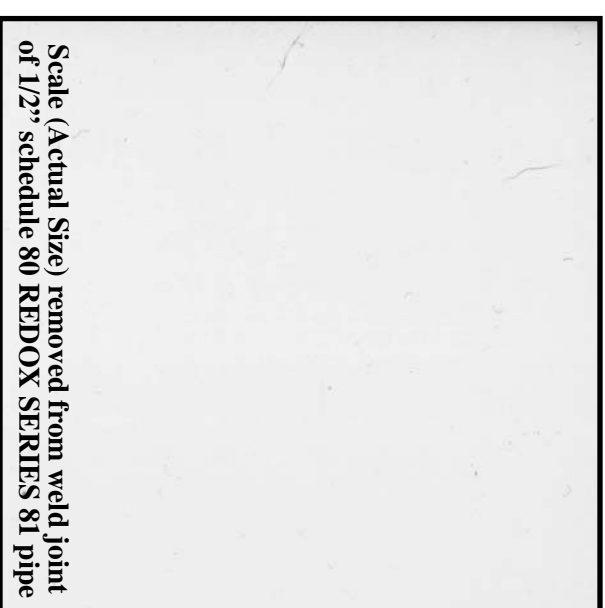
tolerances—yet the cost of installing filters to protect each one would be ridiculously expensive.

The proliferation of these expensive and sensitive components in today’s systems poses new challenges. Servo valves and piston pumps demand that the lubrication be ultra-clean. Failure to give them what they need results in immediate, expensive failures. However, if you examine Figure 3 you will note that the components generally not associated with ultra-cleanliness have demanding tolerances also. The main difference between the two classes of components is that the second group generally will continue to work for a while if subjected to excessive contamination. Although they may continue to work, they are suffering degradation failure which will not show up immediately. Instead, they slowly lose efficiency and generate contamination in the system. The particles then continue downstream damaging additional components. As this process continues, the level of contamination rises further with each component adding more debris. A chain reaction of debris has now started. Its logical conclusion will be system failure.

As will be explained in the section on corrosion, flushing, and filtration, it is impossible to clean the system’s pipe to these close tolerances after the fact. You must engineer and build them with these tolerances in mind. By specifying **REDOX SERIES 81** on your prints, specifications, and purchase orders, you will receive the piping your system requires.

WELDING

In the past, there was generally no mention of any specific welding procedures on prints or purchase



Scale (Actual Size) removed from weld joint of 1/2" schedule 80 REDOX SERIES 81 pipe

Figure 2

orders. This was largely due to the fact that when pickled pipe was welded—it was a foregone conclusion that the weld joint area would form a layer of scale. Using **REDOX SERIES 81** components and welding procedures can eliminate this problem.

Our welding procedures are not only designed to prevent the formation of scale on the I.D. of the pipe but to enhance the general cleanliness of the system. It is important that the welding procedures be called out in the note section of the prints.

Figure 1 compared with Figure 2 shows the dramatic reduction in weld scale that can be realized by specifying that the latest advances be used in your system. By not building contamination into your system, you can expect a quicker and more thorough flush.

FLUSHING

All hydraulic systems need to be flushed to remove incidental fabrication debris prior to operation. It is important to recognize the limitations that exist when using a lubricant to attempt to remove such debris. This will help avoid catastrophic failure associated with it being left in the system.

There are two types of debris that will damage systems. The first is incidental fabrication debris. By designing the system so that all portions of the system achieve the desired flow rate, the fabrication debris will be rapidly flushed away.

The second type of debris is caused by corrosion. The use of black or pickled pipe and fittings in the construction of the system is the source of this

contamination. As will be explained in the next section, if you build corrosion into your system, no amount of flushing will remove the debris. As the metal in your pipe and components continue to degrade, debris will be entering your system to foul filters and damage sensitive valves.

Recognizing the true limitations that ordinary flushing suffers provides insight into why many systems that use pickled pipe fail, even after extensive flushing. Avoiding electrochemically bonded corrosion in your system is a basic requirement. With our adherence to standards that are written by and for the hydraulic industry, a satisfactory flush and a properly operating system is yours as easily as specifying **REDOX SERIES 81**.

CORROSION

In less than a thousandth of a second, oxygen combines with iron to form corrosion. Corrosion is an electrochemical process which cannot be reversed or removed by flushing. The metallic debris that results will degrade the system and require continuous expensive replacements and repairs. These expenditures will be an ongoing problem until the pipe and fitting are replaced with the correct ones.

The heat from welding causes scale to form on the I.D. of pickled pipe. Figure 1 is an example of the scale removed from just one such weld joint. Using the procedures specified in the Tech Sheets with **REDOX SERIES 81** pipe, you can make clean welds like that of Figure 2 become a reality.

The second type of corrosion is the most common and dangerous—red rust. You can not avoid having this type when using pickled pipe. It is not always visible to the unaided eye—but it is always present. Rust is caused by the failure to follow acceptable cleaning procedures when using corrosives on metal. Contrary to popular belief, heavy oil does not prevent the formation of red rust. Once steel has been damaged by corrosives the oil merely suppresses its visible formation. Upon system start-up, the damaged steel is subjected to dissolved oxygen in the lubrication. The combination of oxygen with the intergranular corrosion caused by pickling, produces galvanic corrosion. This results in increasing quantities of metal debris entering into the lubricating oil stream.

Metallic debris from corrosion is the leading cause of hydraulic component failure. Over time, it will damage or destroy all components in any system where it is present. To avoid this costly killer you must use the correct pipe and fittings—those that meet the needs of your system—**REDOX SERIES 81**.

FITTINGS

Fitting need to be as clean as the pipe and components that they connect. Failure to deliver this quality will compromise the system. The use of uncleaned fitting in the typical system will introduce tens of millions of destructive particles greater than 5 microns.

The off the shelf socket weld, butt weld, and threaded fitting sold by steel supply companies are unacceptable for hydraulic use. They are coated with paint and mill scale and frequently contain machining debris that poses grave risks to the system.

In the past, the use of the uncleaned fitting did not pose a risk greater than the inevitable scale that would form when the fitting were welded. But today, with scale-free welding possible, there is no justification for leaving known sources of debris in the system.

Using **REDOX** SERIES 81 pipe and fitting can eliminate the costly problems that plagued yesterday's systems.

FILTERS

Selecting a good filter is no longer a matter of choosing one that has the appropriate micron rating. Today, the tolerances in the system demand that the selection criteria include considerations that were not involved in making earlier choices. To realize the full potential of your system, the contamination level of the oil must not exceed the limits of the most demanding component in the system.

The correct filter will complement the other engineered aspects of contamination control; i.e. correct pipe, fittings, and miscellaneous sources of particles. It is not possible for a filter to protect the system when there are uncontrolled sources of contamination entering it. The reasons for taking a system approach to controlling contamination is two fold. The first is that all filters allow a percentage of particles greater than their rated size to escape. The second is that no matter how good the filter is, it can be overwhelmed if the quantity of particles entering the filter exceeds its ability to maintain the correct downstream cleanliness level.

The particle count that escapes a filter is expressed as a Beta Ratio. This Beta Ratio equals the particles challenging the filter divided by the number that escape that are larger than the filter's rated size. If sufficient particles challenge the filter, it will be impossible for the oil downstream to meet the needs of the most demanding component in the system. The components that are subjected to levels of contamination that exceed their rating will start a chain reaction of additional debris being generated. As the particles enter the system, the rate of particle generation will accelerate until the system fails.

CONCLUSION

Companies that master the ability to operate in a "Just In Time" mode will profit from the efficiency that only a properly engineered hydraulic system can offer. As such systems are

integrated into the manufacturing process, they provide tremendous opportunities to improve quality, lower costs, and quicken turn around time on orders. The success of this integration, and ultimately the company, depends on the engineering decisions and fabrication procedures that are specified for your system. With over 90% of the wetted surface of your system composed of pipe and fittings—the decisions that are made today on the selection of the piping will have an impact on the profitability of your company for years to come. Make the right choice for your pipe and fittings: always use **REDOX** SERIES 81.

TYPICAL OPERATIONG DYNAMIC FILM THICKNESS

Component	Thickness (-m)
Roller Element Bearings	0.1 -1
Journal Bearings	0.5-100
Hydrostatic Bearings	1-25
Gears	0.1
Dynamic Seal	0.05-0.5
Pump, Gear	
Tooth to Side Plate	0.5-5
Tooth Tip to Case	0.5-5
Pump, Vane	
Vane Sides	5-13
Vane Tip	0.5-1
Pump, Piston	
Piston to Bore	5-40
Valve Plate to Cylinder	0.5-5
Servo Valves	
Orifice	130 450
Flapper Wall	18-63
Spool to Sleeve	1-4
Actuators	50-250

Source: ASME 1980 Wear Control Hand Book

Figure 3

REDOX

1605 South 93rd Street
Seattle, WA 98108
(206) 762-8631
FAX (206) 763-9139

S E R I E S 81
REDOX