

## TECH UPDATE

### A brief explanation of oil field dies, the evolution of the CLINCHER™ Tong Die, and advances in hydraulic power tong technology.

SUPERIOR's CLINCHER line of power tongs, backups, and accessories supplies the oil industry with equipment used when installing oil field tubing, casing, and drill pipe. These products are hydraulically powered wrenches which grip the exterior surface of the pipe and transmit torque to tighten or loosen the pipe's threaded connection.

Traditionally, tongs employing a series of hardened steel dies with sharp teeth were used to grip oil field tubulars. Early steel die designs were made from strips of flat bar stock. These early dies ranged from approximately 3/4" to 1 1/2" in width and were approximately 4" long. They are known as strip dies because of their long narrow geometry. These dies were installed in a holder, known as a jaw, in sets of 2 or 4 and arranged in a v-block configuration. The jaws holding the strip dies are installed in opposed pairs in a power tong. As the tong is operated, a cam system generates radial loads which force the jaws to close on the pipe and cause the teeth of the die to penetrate the pipe's surface. (ref. Figure 1)

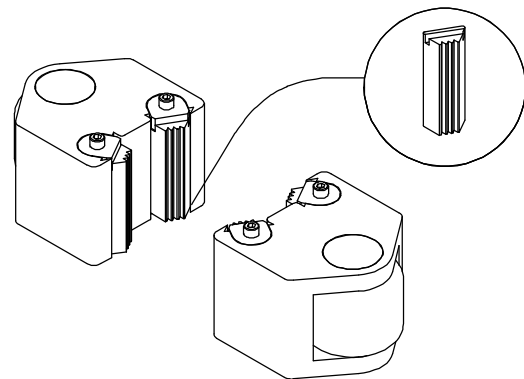
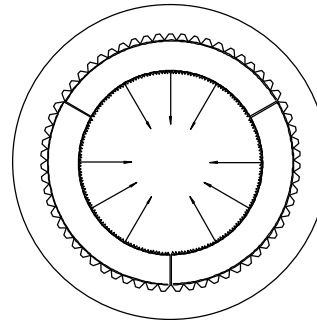


Figure 1

In high torque applications the pipe is loaded on the leading edges of the jaws while the trailing edges are unloaded. Under these conditions, the strip die can severely mark the pipe because the strip die provides essentially only line contact. The limited contact area associated with strip dies can also lead to permanent pipe deformation under high torque conditions. In an effort to reduce the depth of the marks left by strip dies and increase the contact area, strip dies were modified to provide a contoured surface which matched the radius of the pipe.

In 1985 Superior introduced the CLINCHER Splined Tong Jaw and Wrap-Around Fine Toothed Steel Die system (ref. Figure 2). This wrap around die replaced the two traditional tong jaws and strip dies resulting in an increase in contact area to approximately 230 degrees or 64% of the circumference.



Wrap-Around Die System

Figure 2

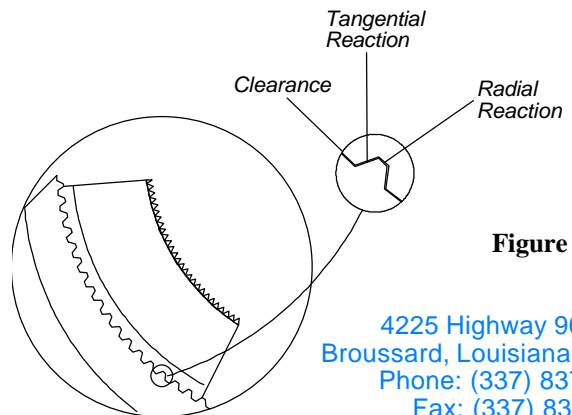


Figure 3

Patented Spline & Die

CLINCHER Wrap-Around Dies are fixed to the jaws by means of a patented spline arrangement which insures proper alignment and uniform distribution of radial loads (ref. Figure 3). This causes the torsional loads to be distributed across the entire die unlike the concentrated loading observed in strip dies. The increased contact area combined with the fine tooth pattern significantly reduces the marking of tubulars under high torque conditions when compared to the traditional die system. Simultaneously, the increased contact area reduces the stress in the tubular and the possibility of permanent deformation. In 1987, we introduced the CLINCHER Hydraulic Backup which also uses our Wrap-Around Die. When these dies are installed in CLINCHER Backups, CHROME-MASTER™ and LOCKJAW™ Tongs having 3 jaws, this contact area is increased to as much as 340 degrees or 94% of the tubular's circumference.

In the last decade, the use of carbon steel tubulars has declined and the use of exotic stainless steel tubulars has increased. This change is in response to declining reserves of sweet, non-corrosive hydrocarbon reserves and the increase in production from hot, corrosive oil and gas reservoirs. Some of these corrosion resistant alloys (CRA) materials can have their corrosion resistance severely degraded if their surface is damaged and/or contaminated with small particles of iron or steel (*ref. IADC/SPE Paper 36386*). The marks left behind by traditional slips and elevators used to handle the tubulars or by the tong dies used to tighten the tubulars can also reduce the mechanical strength and lead to premature fatigue failures. Since these exotic CRA tubulars cannot be used with any type of toothed steel die it became necessary to develop a non-marking die.

CLINCHER Non-Marking Wrap-Around Dies are manufactured from a special aluminum alloy and are machined with a smooth face which matches the radius of the tubular. They grip the pipe and transmit torque without penetrating the pipe by using the frictional force developed between the die and the pipe. Standard tongs used by the oil industry do not develop enough radial load to allow non-marking dies to function. CLINCHER developed its CHROMEMASTER to allow non-marking dies to be used with standard tubing and casing tongs. The CHROMEMASTER works by increasing the amount of radial load applied to the pipe. Three wrap-around non-marking aluminum dies virtually

encircle the pipe to reduce deformation and stress levels in the tubular. For more information on the CHROME-MASTER as well as the CLINCHER Hydraulic Power Tong which drives it and our CLINCHER Hydraulic Backup, contact Superior Manufacturing and Hydraulics.

For a given radial load, torque values for Non-Marking Dies can vary significantly from tube to tube because they are totally dependent upon the coefficient of friction. The presence of a small amount of varnish, moisture such as dew, or some other type of lubricant can reduce this value substantially. If this occurs, the torque values can be increased by the addition of CLINCHER silicon carbide screen cloth. The particles on this cloth are sized to span the film of lubricant between the pipe and the die to increase the coefficient of friction.

CLINCHER GRIT FACED<sup>™</sup> Dies were developed to further enhance die torque capabilities for CRA tubulars and eliminate the need to install a new sheet of silicon carbide screen cloth for every connection. The CLINCHER GRIT FACED Dies are available for our CHROMEMASTER, CLINCHER Backups, CLINCHER LOW-FRICTION<sup>™</sup> Tong Jaws, CLINCHER LOCKJAW Tongs and CLINCHER Bucking Units. GRIT FACED Dies typically provide at least twice the torque which can be achieved using aluminum dies with silicon carbide screen cloth. CLINCHER GRIT FACED Dies do not leave the tooth marks normally seen with conventional steel dies. Like the aluminum dies, GRIT FACED dies do

not allow steel, iron, or carbon to contact the pipe body. The absence of teeth greatly reduces stress risers and crevices which have been observed to cause premature failures in CRA tubing strings.

First proven in critical North Sea applications, the CLINCHER GRIT FACED<sup>™</sup> Die is rapidly becoming the standard die used with CRA strings around the world. When properly used GRIT FACED Dies will not leave any significant marks on the pipe. During recent lab tests the maximum depth of marks left after very high torque applications was 0.004 inches. It is our belief these results are considerably better than competitive systems as they are shallower, are in a random pattern which reduces stress risers in the tubulars, and they do not contaminate the CRA tubing with steel, iron, or carbon. GRIT FACED dies provide another major benefit. Running of the tubulars is faster, safer, and less tiring for operators because they do not have to replace six sheets of carbide paper every joint. Instead, we recommend one die be removed every 10 joints and replaced with a die which has been brushed to remove any accumulated dirt or paint.

The introduction of the GRIT FACED Die brings the number of tong dies available to three as shown in *Figure 4*. The aluminum is a non-marking die used on CRA tubulars at low to moderate torques, GRIT FACED Dies for CRA tubulars at low to high torques, and the fine tooth steel die is used in low to ultra high torque applications on carbon steel tubulars.



Figure 4

Superior Manufacturing & Hydraulics is committed to continually improving our products and expanding our product lines. In early 1997 we introduced the CLINCHER LOCKJAW Tong. Like our other tongs, the LOCKJAW tong utilizes our Wrap-Around Die system (ref Figure 2). This is where the similarity with all other tongs ends. The LOCKJAW features a three jaw system which provides more than 300 degrees of die coverage to further reduce pipe marking under high torques. It also features our patented constant cam angle and a load control system which generates the radial loads required to use our Non-Marking Aluminum and GRIT FACED Dies without a CHROMEMASTER.

In October 1997, CLINCHER introduced its latest tong innovation to the industry. The CLINCHER LOW-FRICTION Jaw System now allows

Non-Marking Aluminum and GRIT FACED Dies to be used in conventional CLINCHER Tongs which are not equipped with CHROMEMASTERS.

These innovations now allow a single tong and backup assembly to be used for running normal steel tubulars, drill pipe, or CRA tubulars. Eliminating the need for separate tong systems reduces capital and spare parts requirements for service companies using the conventional tongs. These mechanical systems will be easier to maintain and less prone to failure than old fashioned hydraulic systems to further reduce operating costs. The simple mechanical system reduces operator training and experience requirements when compared to other systems used with CRA tubulars. The CLINCHER LOCKJAW Tong and the CLINCHER Tong dressed with LOW-FRICTION Jaws are significantly

lighter in weight than competitive systems which will reduce operator fatigue and improve safety. GRIT FACED Dies enhance job safety by reducing operator fatigue and eliminating the need to reach inside a tong and backup to replace the silicon carbide screen cloth at every connection. GRIT FACED dies can also reduce overall operating cost by reducing the time required to run casing and tubing strings.

CLINCHER GRIT FACED Die technology was recognized at the 1998 Offshore Technology Conference in Houston, Texas, where Superior Manufacturing & Hydraulics was presented with a Special Meritorious Award for Engineering Innovation by editors of *Petroleum Engineer International*.

## GRIT FACED Inserts for Slips, Elevators and Safety Clamps

As part of our ongoing program providing tubular handling innovations to the oil field, SUPERIOR Manufacturing & Hydraulics is pleased to announce we are now providing inserts for slips, elevators, and safety clamps which feature our GRIT FACE Technology (ref. Figure 5). This technology, field proven in tong applications, now provides the industry with handling tool inserts designed to protect CRA tubing and casing strings from the hazards associated with the use of conventional steel toothed inserts. A combination of exotic materials used in these new inserts protect CRA tubulars from contamination associated with conventional steel inserts.

GRIT FACED inserts are offered to fit almost all types of tubular handling tools. We provide our inserts for manual and power slips/elevators used to handle tubing, casing, drill pipe and drill collars. Safety clamp inserts are available for handling drill collars and downhole tools. Inserts are also available for manual tongs used with tubing, casing, and drill pipe.

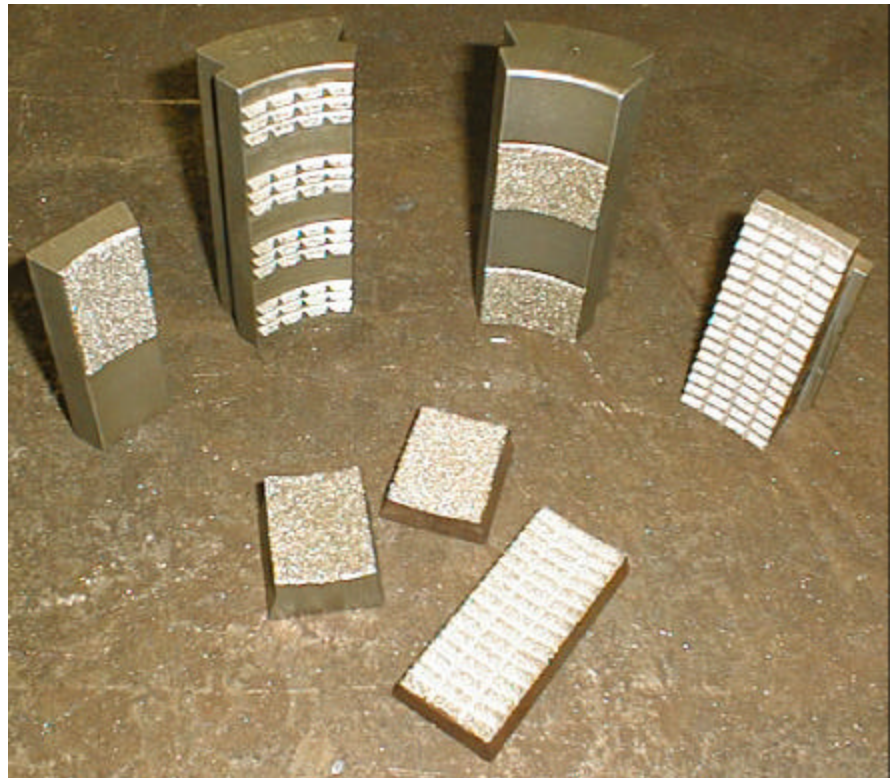


Figure 5

Two different styles of GRIT FACED inserts are available. One has a cylindrical surface which has been coated with our grit material. This style insert, known as a "smooth" insert because it doesn't have any teeth, is used to handle most CRA tubular goods. The "smooth" insert will accommodate tubulars who's OD is coated with moderate amounts of foreign materials such as pipe mill coatings. Our insert style has "teeth" which are coated with our grit material to protect the tubulars from iron contamination. The mud grooves and recesses between the teeth provide room to accommodate large amounts of foreign materials which are often found on the exterior of tubulars when removed from wells.

To insure maximum effectiveness during use, both types of inserts must be periodically inspected and cleaned of foreign materials using a wire brush.

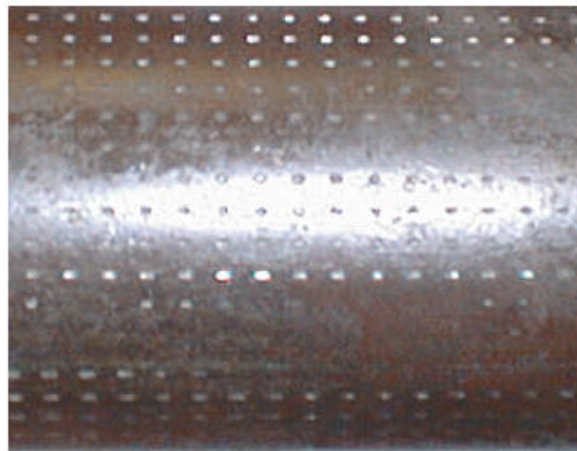
Our in-house laboratory testing, and tests performed by an independent third party have demonstrated the marks left on tubulars by both of our insert styles are almost negligible. While our GRIT FACE insert system is not totally non-marking, the depth of the imprint left on the tubular after the application of very heavy loads is significantly less than the depth of slip marks left by conventional inserts. Smooth style GRIT FACED inserts do not leave aligned "slip marks" which are known to reduce mechanical strength

and lead to premature corrosion or fatigue failures in tubular goods. *Figure 6* compares the marks left by "smooth" GRIT FACED inserts with standard toothed inserts. Close examination will show it is almost impossible to distinguish the impressions left by the GRIT FACED insert from the normal pipe mill surface imperfections. It is our belief these results are considerably better than competitive systems as they are shallower, are in a random pattern which reduces stress risers in the tubulars, and they do not contaminate the CRA tubing with steel, iron, or carbon. As an additional benefit, our GRIT FACE insert system does not require specially adapted handling tools so it can be used with almost all handling tools in use today.

Typ. Pit Depth  
0.0025 – 0.003"



Typ. Pit Depth  
0.005 – 0.006"



Comparison of marks left in 2 3/8" OD - 4.6 ppf 13% Cr 85 ksi Sy tubing by GRIT FACED Inserts (left) and by conventional toothed inserts (right). Unretouched digital photo at approximately 1X.

Figure 6

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US and foreign Patents Pending. CLINCHER, CHROMEMASTER, LOCKJAW, LOW-FRICTION and GRIT FACE are marks of SUPERIOR Manufacturing & Hydraulics.

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