CSITP – #2 Pipe Mill

a NUCOR-JFE company

CSITP's #2 Pipe Mill is a state of the art facility geared toward producing American Petroleum Institute (API) compliant pipe for the long distance transmission of oil and gas. Able to produce pipe in a wide range of sizes, from NPS 8 (8.625" in diameter) to NPS 24 (24.000"), wall thickness from 0.156" up to 0.750", and API grades from B to X70, this pipe mill is able to cover a large portion of commonly requested products.

Pipes are provided in lengths up to 80' and are fully inspected and ready for coating, with the ends prepared for field welding. Pipe can be loaded for delivery via either rail or truck.

INCOMING MATERIAL

CSITP utilizes pipe skelp rolled at CSI's own Hot Strip Rolling Mill for all outer diameters up to and including 20", and all wall thicknesses up through 0.500". Coils can be rolled on site with minimal lead time, and can be processed at the Pipe Mill as soon as they are cool.

COIL PREP / SPLICE STATION

Once the coils are brought over to the mill, the process begins by verifying the identity, width, and gauge of each coil before loading the coils onto the coil saddles at the entry end of the line, and entering their identity into the mill computer system. The computer aids the operator in bringing the coils to the uncoiler, where the bands are removed and the head end of the coil is fed through a leveler to flatten it. The end of the coil is sheared to make a square end, and the head end of the coil is welded to the tail end of the previous coil, using four gas-shielded flux-core welding torches – two from each side of the strip to create a two-pass weld in less than two minutes. This process creates a continuous strip that can be fed into the accumulator, and eventually be made into a continuous pipe on the other end where it will be cut to length.

ACCUMULATOR

The accumulator serves as a buffer to allow the forming and welding line to maintain continuous operation while the splice station is preparing and welding another coil into the chain. The design of the accumulator is a compact spiral strip accumulator with the strip wound 31 times around a 30-foot diameter center section and 50-foot outer section. During the course of normal operation, the mill pulls coil out of the accumulator causing the spiral winding to shrink in diameter while the coil prep / splice station feeds coils to keep the accumulator from running out of steel.

EDGE MILLING

After leaving the accumulator, the strip passes through the edge milling station. The edge milling equipment has two 43" diameter milling wheels spinning at a speed of up to1350 rpm. Each milling wheel is equipped with 60 or 70 individual carbide cutting tools around the outside. Once the strip passes through the edge milling station the edges have been trimmed to the exact width needed to form the strip into pipe, and the edges are flat and suitable for welding together once the strip exits the forming section.

FORMING

Finally, the strip is ready to begin the process to form it into pipe. The breakdown section is where the process begins by drawing the strip into the forming section with a set of pinch rolls. Following that, the edges are bent up slightly in the edge bend section, then the strip passes through a series of rolls on all sides to start the deformation. The breakdown section uses two rolls to "break" the strip and start the deformation near the centerline of the strip.

After the preform / breakdown section, the next section consists of rows of free spinning rolls that constrain the strip on all sides to provide even deformation and help guide the strip into an open "O" shape. The deformation process here has been carefully designed to help reduce residual stresses and provide uniform strain in the "O-forming" process.

Once the strip exits straightedge forming it passes through the three finishing pass “fin-pass” stands. Each stand consists of four rolls: one on the top, one on the bottom, and one on each side of the pipe.

The stands are called fin-pass stands because the top roll is bisected by a larger diameter disk, called a fin blade, that allows the edges of the strip to rest on either side, fully constraining the open channel. In addition to helping constrain the strip, the fin blades also help further flatten and prepare the edges of the strip for welding, ensuring that the presentation angle of the strip edges is correct to allow optimum welding.

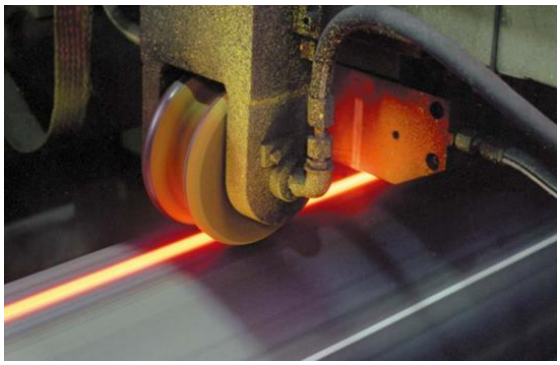
WELDER / SQUEEZE STAND

Without a doubt, the welder is the heart of the Pipe Mill. Its job is to provide the power necessary to heat the strip edges to create the longitudinal weld in a process known as High Frequency Welding (HFW). This process uses high frequency electric current to heat a small area – just the very face of the strip edge on both sides – and then mechanical pressure provided by passing through the squeeze stand causes a high quality forge weld to be created.

This welding process has more in common with a weld created by a blacksmith forging a broken tool back together than it does with the arc welding processes that many people are familiar with. Only a very small amount of metal on the very edge is melted, and any melted metal or oxides are expelled when the edges are pressed together, creating a very strong weld without the addition of any filler metal.

A major difference between the weld created by the HFW process and the aforementioned blacksmith is the very precise application of heat and forging pressure that is possible using today’s technology. The welder uses solid state electronics to provide up to 1,800 kW of power at a frequency of 100 to 200 kHz to a copper induction coil suspended around the pipe. This copper induction coil creates intense magnetic fields that transfer the power into the pipe without even touching the pipe. Once the edges come together at the welding apex, they are squeezed to create the forge weld. Any excess metal on the inner or outer diameter of the pipe is trimmed away to create a smooth surface.

MILL ULTRASONIC INSPECTION



As soon as the pipe is made, the inspection process begins. One of the very first, and possibly the most important inspection that is performed is the mill ultrasonic inspection (UT). The mill UT is located right after welding and trimming, and it inspects 100% of the pipe that is produced at CSI for the oil and gas industry. The ultrasonic inspection works by bouncing high frequency sound waves (ultrasound) through the weld of the pipe with a search unit. Any reflections of sound that bounce back to the unit indicate possible discontinuities in the pipe, and an automated paint system will mark that section of pipe to be manually inspected once the pipe reaches the manual inspection tables at the end of the process.

ANNEALING

After inspecting the weld, the pipe enters an enclosed area where the induction annealers are housed. In the HFW process, the high heat extraction during welding results in a weld seam that is harder and more brittle compared to the rest of the pipe. In order to toughen the weld seam to better match the properties of the rest of the pipe, induction annealers are used to heat treat the weld seam to an annealing temperature from which the pipe is allowed to slowly air cool, resulting in a weld seam with improved mechanical properties such as high absorbed energy and high shear fracture characteristics.

The annealing system at the #2 Pipe Mill consists of three annealing “sleds” which are independently set to the desired power level, each utilizing independent pyrometers to measure the temperature of the annealed weld seam. The three sleds are able to traverse together up and down the continuous length of pipe within the annealing enclosure, allowing them to back up and go over an area again to ensure that as much of the weld seam as possible is heated to the correct temperature as it passes through the enclosure.

AIR COOL / SIZING

Next, the pipe proceeds down the line for almost 300 feet to give the weld seam time to air cool. After the weld seam is cool enough that the mechanical properties are locked in, the weld seam is rapidly cooled with water to allow it to pass through the sizing mill. The sizing mill consists of a de-twisting section and four sizing stands consisting of four rolls each. The sizing stands help to make the pipe almost perfectly round, to within a few ten-thousandths of an inch.

FLYING CUT-OFF

At last the pipe is ready to be cut into lengths. Just as the accumulator allows the mill to keep running while the splice station welds another coil, the cutoff is designed to cut the pipe to length without having to stop or slow the mill. The cutoff is able to accomplish this because it is mounted on a traversing carriage, allowing the cutoff to clamp onto the pipe and ride down the line while making its cut. The cutoff computer monitors for the coil splice weld, and initiates cuts automatically to ensure that the pipe is being cut to customer specifications. The splice weld is also cut out along with at least 10 feet on either side of the weld, as that section of pipe is not suitable for oil and gas transmission. Two tungsten-carbide tipped saw blades spinning at over 1,000 rpm make each cut in less than 15 seconds.

PIPE HANDLING

Now the pipe is in discrete lengths. Once the pipe leaves the cutoff, it is given a unique identifying bar code, printed along the side of each pipe. Throughout the entire process from the cutting of the initial pipe, finishing, hydrostatic testing, ultrasonic inspection, and final inspection, CSI uses cameras and a mill level II computer system to track the progress of each pipe. All combined, the creation, inspection and testing results of each pipe are recorded and maintained in a CSI data base.

The pipe is then handed off to a walking beam which picks up each length of pipe and deposits it on a chain conveyor, advancing the pipe transversely to the next unit. Throughout the remainder of the process, the pipe is transferred from station to station by a network of roll lines, skids and tables for the pipe to roll on, kickers, and receivers.

CROPPER

The cropper's main job is to cut test rings from the pipe for the various testing methods that are used to ensure that the pipe meets the stringent standards required by API and the customer. Using two plasma torches on a rotating barrel around the pipe, the cropper is able to cut two 3" rings at the same time, or one ring at a time of whatever length is required. The cropper can also cut off portions of the pipe that do not meet requirements. CSI uses two croppers, one located right after the cutoff and the runout table, and another mainly used to process rework located just before end facing.

FINISHING

The end of each pipe is prepared for field welding by machining a bevel into the end of the pipe at the end facers. Next, the pipe is washed out and sent to the hydro testers. Each order begins by being tested to 100% of the minimum required yield strength up to a maximum of 8000 psi for some of the small, heavy gauge sizes. The pipe is tested with the weld seam facing up, so any leaks are easily detectible by the operator and the pipe can be rejected.

INSPECTION

Following hydrotesting, the weld seam on the pipe is ultrasonically inspected a second time, using a search unit calibrated to a piece of pipe with an artificial defect in it consisting of a 1/16" drill hole, and a notch cut through 5% of the wall thickness on both the ID and OD. The system is also capable of inspecting the area around the weld seam known as the heat affected zone (HAZ) for laminar defects, or "laminations", as well as performing full body lamination inspection of the pipe, looking for laminar defects/separations within the base steel that the pipe is made from.

CSITP's #2 Pipe Mill is also equipped for electromagnetic flux-leakage inspection. This inspection is best at detecting surface and subsurface defects, as well as detecting weld-line and other defects. This greatly aids the final inspectors in ensuring that any imperfections that could affect the ability of the pipe to be properly coated are detected and can be repaired.

Finally, the pipe goes to the final inspection area. In this area, ASNT TC-1-A certified Level II ultrasonic inspectors manually check and prove-up any suspect areas identified by the Mill UT, Final UT, or Amalog. The pipe is also visually inspected inside and out, and all necessary dimensional measurements are taken to ensure that the pipe meets tolerance for OD, wall thickness, ovality, straightness, and length.

Once all the inspections are performed, the inspectors grade the pipe as prime, tracked in the computer system, and the pipe is sent on to be weighed, marked with a stencil, including the API monogram, and marked with color bands for identification and storage until the pipe ships to the customer, or if requested, to the coating facility.