Western Instruments
Established 1965

Lamination Testing

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Background

There is a concern about the presence of what is loosely defined as “Laminations” in tubular products and they have arisen out of a variety of installation and service conditions.

The most common concern, for field welding, with respect to line pipe are laminations which show up in the beveled ends of the pipe. Here laminations create problems when fusion welding is carried out. There is a small amount of forge welding that is also done and laminations in the ends of pipe create problems here as well.

There are service conditions, particularly when the fluids being passing through piping systems containing various chemical compounds. In particular where there are sour conditions in the fluids, or other conditions which create atomic hydrogen. End User ‘Supplementary Specifications’ have been developed, as typical industry specifications, such as API-5L, PSL2, are not particularly definitive with respect to acceptable lamination conditions. We have also found laminations, which due to particular circumstances of the steel making and rolling process, which will actually come to, or near, either the outside or inside surfaces. We have investigated laminations for customers and have documentation on failures from such a conditions.

There is no real definitive description of what a lamination is, but generally, the accepted practice is; If an ultrasound reflection is received from an interface that is below the inside or the outside surface, a lamination has occurred. Typically laminations occur near the mid-wall and this is due to some different factors.

Segregation, particularly non-metallic inclusions, will tend to be concentrated in the mid-wall area of the wall thickness. Furthermore, when the strip progresses through the forming process, the rolling (or bending) to form the flat into a round, induces the maximum shear at the mid-wall area. Therefore, these two sets of conditions puts the laminations close to the mid-wall position.

Laminations were particularly prevalent when Strip (Coil) was rolled from Top Pour Ingots, and was improved with Bottom Pour Ingots (slabs). However, modern Steel Making processes utilizes Continuously Cast and rolled material, and has virtually eliminated “Piping Laminations”. Unfortunately, the pipeline industry is slow to change their ways, and many still insist on extensive Lamination Inspection. In the writer’s opinion over 90% of laminations could be detected by a single probe inspecting the 6 O’clock position after forming has occurred. This area represents the maximum point of shear stresses.

Strip Testing

We do not recommend oscillating probes, as it is difficult to define what is acceptable and what is not acceptable in the way of laminations that may be detected. We

normally propose static, multiple probes as defined in specific Supplementary Specifications. The maximum number of probes provided would be used on the widest strip and then progressively fewer probes as the strip gets narrower. Furthermore the operating and maintenance of oscillating probes is much higher than for probes that do not oscillate. It is of course, necessary to have specific probes on the edges of the strip, where there is greatest concern for laminations occurring.

Our first experience with strip lamination testing dates back to approximately 1959 and to our knowledge we did the first on-line laminations strip testing. We found that testing in the strip, was not very useful because there were few indications ever found. If fact, there is seldom a condition in the strip that has a reflective interface that is detectable with ultrasonic testing. We, and others, have observed visible laminations on the slit edge, but these would not provide a reflective signal. Normally segregation, which leads to the formation of laminations in the strip, is transparent to ultrasound.

Segregation in the strip will tend to open up during the forming process, which is due to the maximum shear stress (cold work), mentioned previously. Therefore, in our opinion, testing for lamination in the strip can be justified only to meet a low performance specification.

Mill**-line lamination testing**

Dating back to early 1960, we performed Ultrasonic Lamination Testing at the same location as the Weld Line Testing. That location being immediately after scarfing, or in the sizing section. Within hours of installing equipment, after welding, laminations were found. Typically the most useful positions for such Mill-Line lamination testing is; near the weld testing probes, on either side of the weld; and at the 6 o'clock position, where the maximum shear will occur. In other words, these 3 locations are at approximate 11:00, 1:00 and 6 o'clock positions. Finding laminations in this area alerts the mill operating personnel of problems in the strip or in the forming process.

Finishing Line Testing

Most specifications for pipe require the ends of the pipes to be tested for laminations in part because of the problems laminations cause during field welding. Some Supplementary Specifications, for Lamination Testing, go further and state that Lamination testing is to be performed prior to Beveling and if the End is Beveled the Probes must contact the pipe form the inside to ensure the bevel is fully tested as well.

Body Testing

Our company has built a variety of body lamination testing systems ranging from hand-held probes to fully mechanized systems. These impressive mechanized systems integrate weld testing, with end, body, and weld edge lamination testing. However, in our experience, it is best to separate the finishing line weld testing from body lamination testing to ensue a match of through-puts. Furthermore, testing systems with less automatic features are far less expensive to maintain and operate.

Conclusion

In any case, all specifications agree that, final inspection must take place after all cold work (hydrostatic testing, straightening, etc.).