

TECHNICAL BULLETIN

SENSITIZATION LEADING TO EMBRITTLEMENT AND POTENTIAL FAILURE DUE TO OVERHEATING DURING MANUFACTURE OR REPAIR OF DOT-4L AND TC-4LM LIQUID CYLINDERS

A repair facility received a liquid cylinder in nitrogen service with the outer vessel safety device activated, which indicates the likelihood of an internal leak. Examination of the inner vessel demonstrated brittle failure of both the inner top and inner bottom heads and degradation of the insulation materials. Metallurgical investigation confirmed sensitization leading to embrittlement of the failed areas consistent with overheating of the inner vessel during a previous repair.

Maintenance or repair of DOT-4L and TC-4LM liquid cylinders may require evacuation of the annular space. Internal heating of the cylinder is a common practice in this evacuation process. ASTM A240 Type 304 austenitic stainless steel used for the inner vessel of DOT-4L and TC-4LM cylinders is subject to sensitization leading to embrittlement and potential failure if excessively heated. A brittle failure of the inner vessel can occur if the inner vessel of the liquid cylinder is overheated and then subjected to in-service loads and impact damage. This results in immediate discharge of the inner vessel contents via the outer jacket safety device.

In general, heating the inner vessel higher than 885 °F (474 °C) can lead to sensitization leading to embrittlement and potential failure of stainless steel liquid cylinder components [1]. However, depending on the heating method used, significant variations in temperature over the length of the inner vessel can occur and measurement of liquid cylinder temperature in a single location does not give assurance that localized heating to higher temperatures did not occur. Embrittlement can be localized and can only be confirmed with a complete cut apart of the liquid cylinder and detailed inspection of affected materials.

Liquid cylinders heated higher than 700 °F (371 °C) are at risk of ultimately resulting in an embrittled condition. Any liquid cylinder that has experienced heating higher than 700 °F (371 °C) should be permanently removed from service and disposed of properly. Federal, state, provincial/territorial, and local governments regulate the disposal of pressure vessels. Do not dispose of a liquid cylinder without knowing and fully understanding all pertinent safety and disposal instructions and regulations. Consult the cylinder manufacturer's operations manual for proper instructions on liquid cylinder disposal. Consult your local government for information pertaining to disposal regulations in your area.

References

Unless otherwise specified, the latest edition shall apply.

[1] ASME Boiler & Pressure Vessel Code, ASME International, Two Park Ave., New York, NY 10016.
www.asme.org

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