

# **In-Situ Neutron Diffraction Study of Residual Stress in Steel Ammonia Nurse Tank Welds**

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## **ABSTRACT**

Anhydrous ammonia nurse tanks are steel tanks mounted on running gear to transport liquid ammonia over roadways from commercial distributors to farm fields. The U.S. fleet of 200,000 anhydrous ammonia nurse tanks is aging, and a few are starting to fail, releasing toxic ammonia and sometimes injuring farmers and agribusiness workers. At one atmosphere pressure, ammonia (NH<sub>3</sub>) boils at -33°C; therefore, liquid ammonia must be stored at high pressure to avoid rapid loss by boiling. Nurse tanks are manufactured by welding hemispherical steel end caps onto the ends of a steel cylinder; the cylinder is fabricated by welding along longitudinal seams. Tank failure accident reports show that the principal causes of failure are defective welds and stress corrosion cracking in or near welds. A key parameter in modeling the stress state in these tanks is the residual tensile stress from welding the tank together during manufacture. These measurements, significant in that the welded sample was over a meter in diameter, 30 cm tall, and with a wall thickness up to 15mm, highlight the ability of neutrons to probe large samples at depth. The measurements provided a comprehensive profile of residual stresses in the steel around the circumferential weld in a representative nurse tank which will be combined with other, more easily calculated, stresses resulting from the internal pressure in the tank and from the weight of the ammonia to offer the first complete data file of total stress in a nurse tank.

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