

## Saba Metallurgical & Plant Engineering Services, LLC

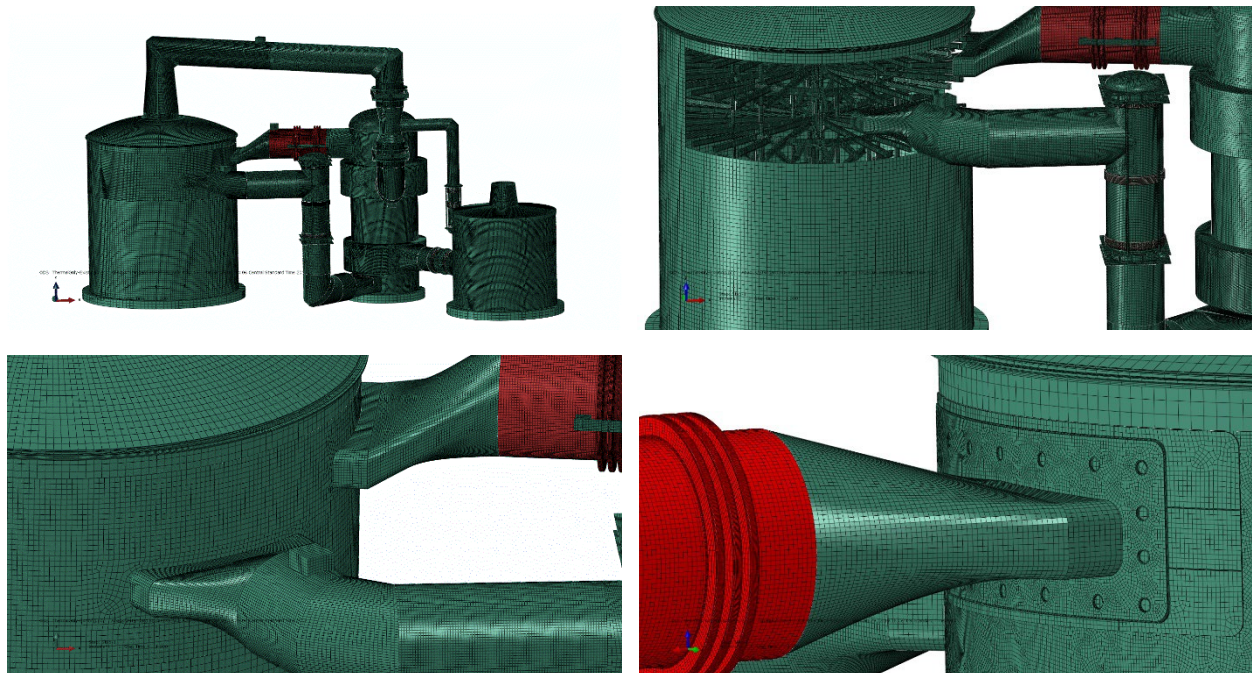
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### **Sulfuric Acid Reactor Nozzle – Mechanical/Weld Repair Plan (Finite Element Analysis, Welding Procedure, and Lab Services)**

*Project Description:* A large fishmouth nozzle on a sulfuric acid reactor was experiencing repeated cracking failures. Testing indicated that the area around the nozzle had pockets of both spheroidization and graphitization, as indicated by laboratory services on physical plate taken from the shell outside the nozzle. A weld repair would need to combat these metallurgical issues as well as the need for postweld heat treatment (PWHT) for the 1-1/2 Cr ½ Mo material. A unique repair plan was devised to insert a new nozzle into a new opening in the shell, welded using a temper bead weld technique (in lieu of PWHT). A FEA model was made of the unit as a whole, with interconnecting piping, expansion joints, and supports. Changes were made to the piping leading to this nozzle to reduce the stress and help prevent future cracking problems. The new repair nozzle was installed to the FEA model and confirmed for adequately low stresses.

*FEA Model:* The meshed FEA model is shown in the below images:



*FEA Results:* Original stress images are shown in the first image on the next page, highlighting general areas of concern. The next two sets of images show side-by-side comparisons of the before and after repair for stress and (exaggerated) deflection. The removal of the forced bending of the connecting piping to this nozzle is quite evident. Equivalent plastic strain is shown in the last image.

