8-4 Approach towards an Explication of the Corrosion Mechanism for Reprocessing Plant Instruments —Investigation of Causes of a Failed Steam Jet and Improving the Jet Design—

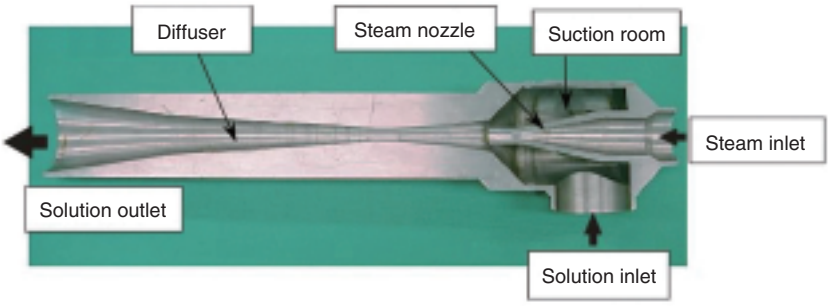

Fig.8-5 The configuration of a steam jet (SJ)
SJ is an instrument which transports solution by making steam blow out from a steam nozzle. Material of a failed SJ is equivalent to JIS-SUS304L, and operating time up to the accident was about 60,000 hours. Operating conditions:
(1) Steam temperature : About 170℃
(2) Temperature of the waste fluid : About 40℃
(3) Nitric-acid concentration in waste fluid : 2～3 mol/L
(4) Designed flow : 4m^3/h

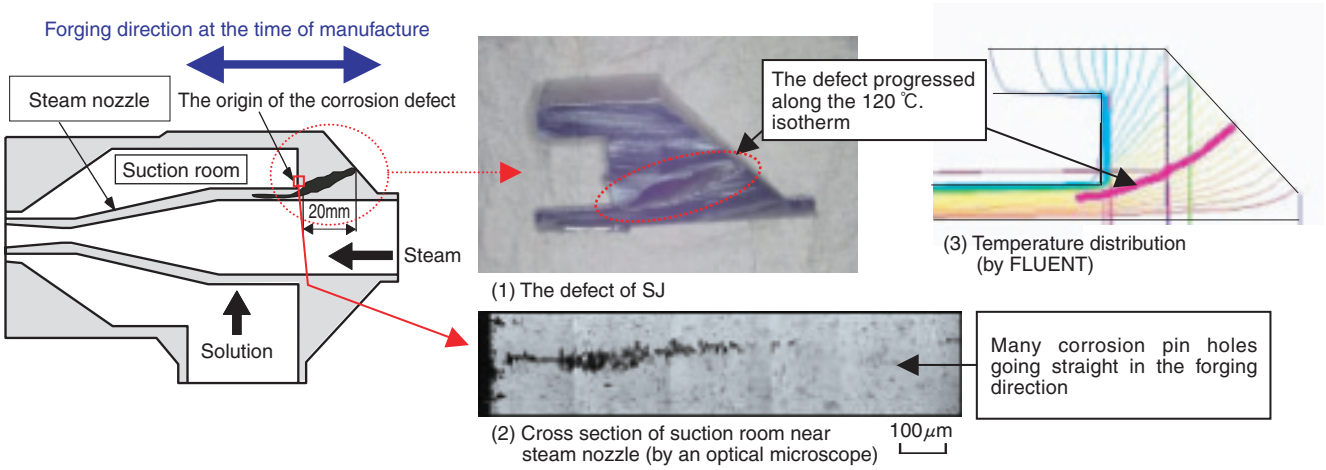

Fig.8-6 Defect and temperatures evaluation of a steam jet (SJ)

A corrosion accident occurred in the steam jet (SJ) during acid recovery processing at the Tokai reprocessing plant. About 400 SJ are used to transfer solution in cells where radiation doses are relatively high in the plant (Fig.8-5). Such a corrosion event in an SJ had never occurred in the 30 years of the plant's operation, so we investigated it from many aspects and determined the cause.

First of all, we retrieved the SJ from the cell and observed the inside by a high precision CCD camera and X-rays. As a result, it was revealed that corrosion had created cavities inside of the structure which extended to the outside surface (Fig.8-6).

Next, we made the following investigations to ascertain why such a failure occurred.

(1) Observation of constitution by a scanning electron microscope (SEM) and componential analysis by an X-ray micro analyzer (EPMA).
(2) Analysis of the temperature distribution of the structure and verification by experiment using a mock-up system.
(3) Investigation of the correlation between the processing direction of the structure and corrosion progress by corrosion test.

Consequently, it was revealed that the corrosion defect started with pin holes at the steam nozzle base connecting with the inlet portion, at the surface where nitric acid fluid had been in contact, and the defect progressed from the nozzle base along the 120 ℃ isotherm.

Moreover, we proved the following points regarding improvement of SJ design.

(1) R-SUS304 ULC-SA material has high corrosion resistance, so it is effective as the material for an SJ which is used for a long time.
(2) Smoothing the surfaces at the nozzle base which is the starting point of corrosion makes fluid flow smooth and lessens the temperature rise.

Reference

Shimizu, R., Takaya, A., Shirozu, H. et al., Investigation of Causes a Failed Steam Jet and Devising an Improved Jet Design, Nippon Genshiryoku Gakkai Wabun Ronbunshi, vol.4, no.3, 2005, p.203-212 (in Japanese).