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# Final Project Report

# CRADA with Viatec Recovery Systems, Inc. and Pacific Northwest National Laboratory (PNL-076): Final Report with Viatec

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# Final Report with Viatec

## Purpose/Objective

The purpose of this project was to support completing the commercialization of a DOE developed technology by testing new materials of construction to be used in critical components of the Waste Acid Detoxification and Reclamation (WADR™) technology; which is being commercialized by Viatec Recovery Technologies, Richland, Washington. The objective of the project was to test the thermo-mechanical properties of polyvinyldiene fluoride (PVDF), which is the material of construction for the tubes in the heat exchangers. The results of the testing were used to design systems successfully installed and tested at Watervliet Army Arsenal and in a mobile system that was demonstrated in Japan.

## Summary of Activities Performed

The testing performed in support of this ER-LTA CRADA included testing the mechanical strength of PVDF tubes at high temperatures in a specially constructed fixture (see attached figure). Viatec Recovery Systems provided the materials, tested weld coupons, and built two heat exchangers using the new design information.

Knowing the thermo-mechanical properties of PVDF is critical in designing heat exchangers. Thermo-mechanical properties refer to the strength of the material at elevated temperatures. By determining the thermo-mechanical properties of PVDF, the potential applications of the WADR™ technology can be expanded with confidence to operating at higher temperatures and more concentrated acids.

During testing, a mixture of phosphoric and sulfuric acids was placed into the 8-mm or 12-mm tubes and the inside of the tubes was evacuated to a full vacuum. The steam was introduced into the outside of the tubes to both heat up the tube and apply an external pressure. The tube was then exposed to both an internal vacuum of –13 psi and an external pressure of up to 47 psi or a total differential pressure of up to 60 psid. The tube was observed through the glass window and the experiment was terminated when the tube collapsed and the temperature and pressure recorded.

Testing in the apparatus was performed on 12-mm and 8-mm diameter PVDF tubing ranging up to 290°F and 60 psi differential pressure. The 12-mm tube collapsed at an average tube wall temperature of 277°F and a total differential pressure of 40 psid while the 8-mm tube collapsed at an average wall temperature of 280°F and a total differential pressure of 60 psid. Testing both tube diameters under operating conditions achieved a consistent value of 65,000 – 70,000 psi for the tensile moduls (E) at 270-290°F. This mechanical property was very important in designing future thermoplastic heat exchangers.
The effect of hydraulic water hammer on tube behavior was also studied. Water hammer is the phenomenon of a high-pressure wave that is created when flowing liquid is stopped

rapidly as when a valve is rapidly closed. The high-pressure wave can be 5-10 times higher than the system pressure and can severely damage piping. This phenomenon was generated by rapidly closing the cooling water valve and observing any effects on the tube. No damage was observed under any water hammer conditions.

**Significant Accomplishments**

The significant accomplishment for this project was to define maximum operating conditions for different sizes of PVDF tubing. This data was critical in redesigning the heat exchanger for two WADR™ systems at a federal facility, Watervliet Aresenal. In addition, the data was used in designing heat exchangers for an overseas demonstration system as shown in the attached figure.

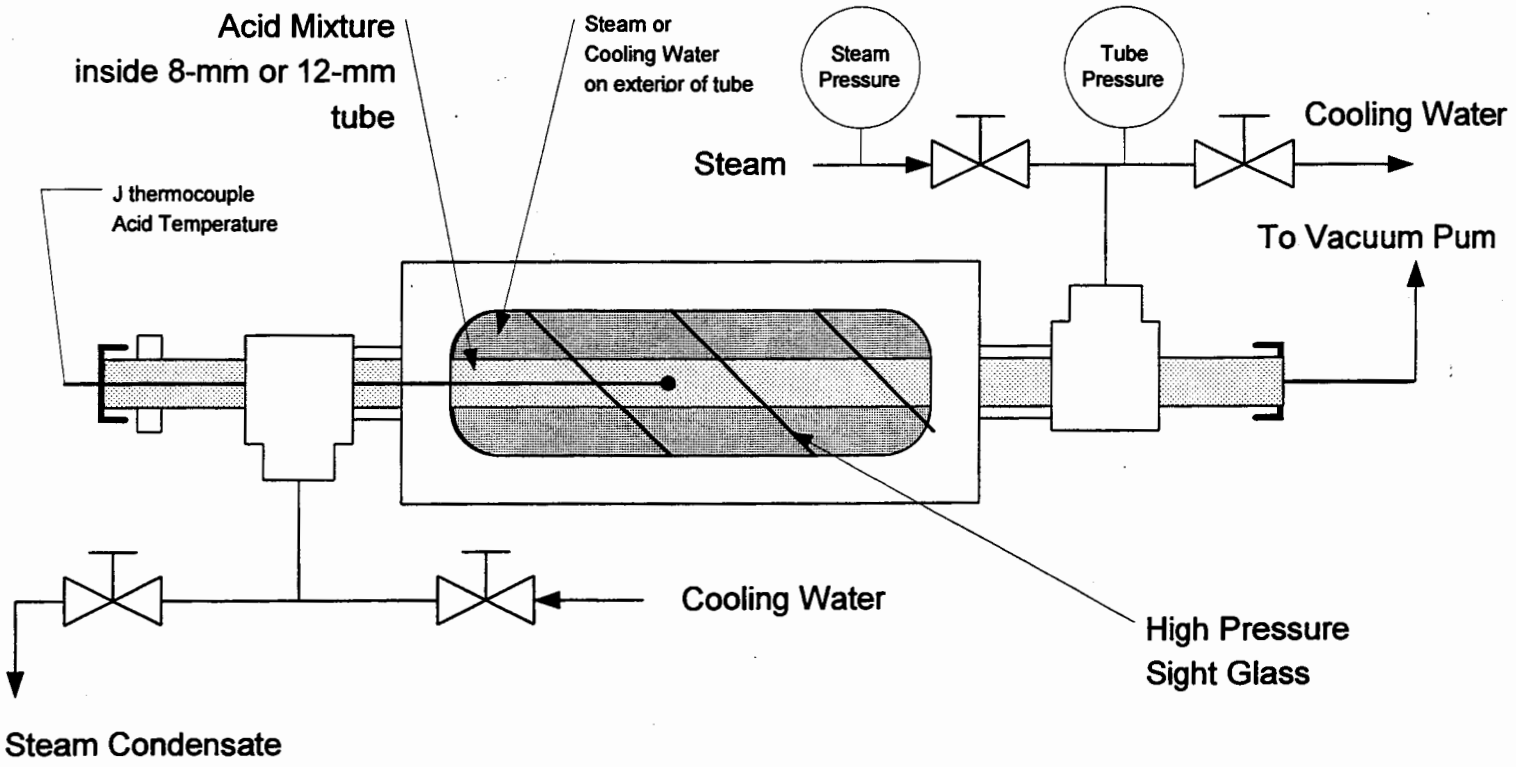
**Significant Problems**

No significant problems were encountered in the project.

**DOE/Laboratory Benefits Realized**

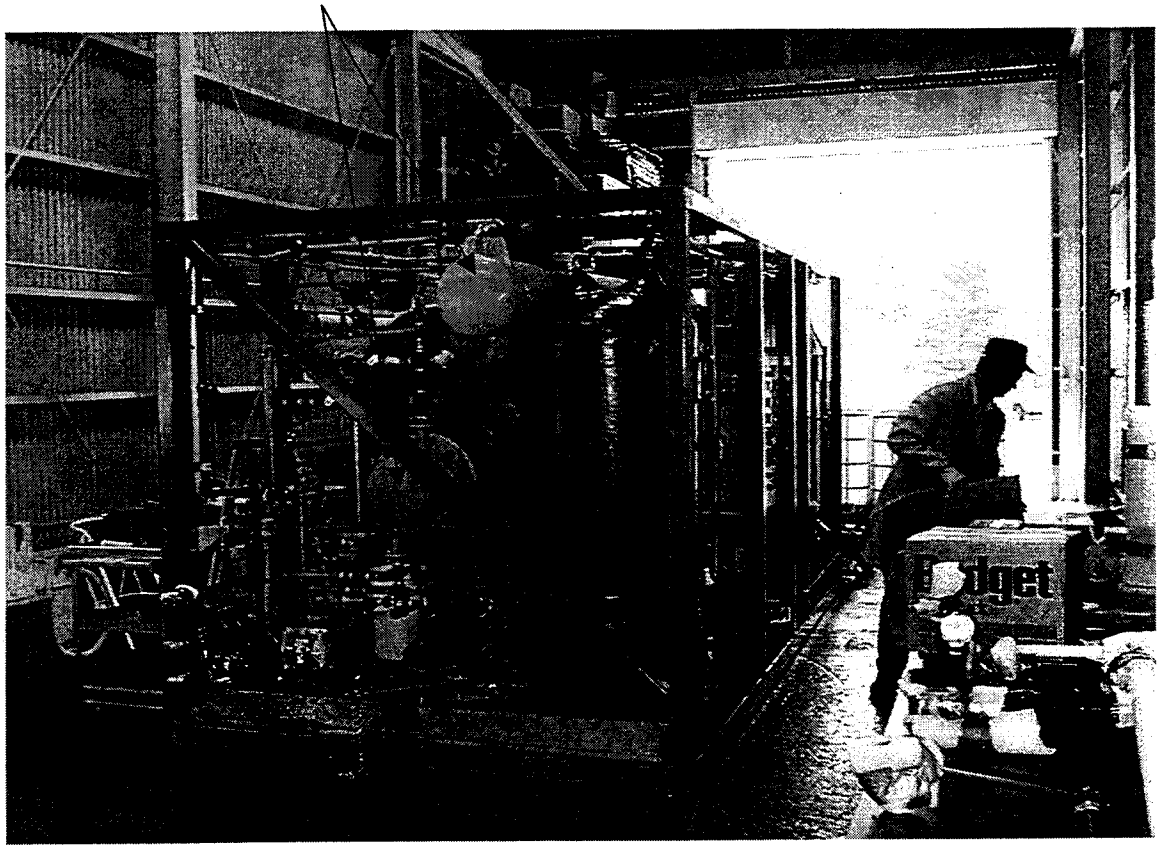
The DOE benefited from this project in that another jointly funded DOE/EPA demonstration system was able to use the data generated in this project to design a more robust system. In addition, the data on the thermo-mechanical properties will have direct application in recovering spent acids generated during calcination of wastes at INEEL. To minimize the generation of $NO_X$ during the calcination of acidic radioactive wastes at INEEL, the acids will be recovered prior to calcination. Designing, installing and operating an acid recovery system using the data generated from this project can save several million dollars.

# Thermo-mechanical Test Apparatus



Assembling the Overseas Demonstration System

Heat
exchangers



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