RETROFIT OF EXISTING DOW SOLIDIFICATION SYSTEM AT QUAD CITIES NUCLEAR STATION

Louis DeRitis and Neil Jarvis
Atcor Engineered Systems, Inc.

James Testa and Raymond Petri
Commonwealth Edison

ABSTRACT

Over the past year ATCOR has been involved in the design, testing and supply of an In-container Mixing System Retrofit for Commonwealth Edison's Quad Cities Nuclear Station Solidification System. The system supplied by DOW, itself a retrofit of a urea formaldehyde system, was based upon use of 50 cubic foot containers (liners). ATCOR's retrofit increased liner capacity to 170 cubic feet and allowed in-cask solidification of highly radioactive material.

This paper discusses the reasons for the decision to replace equipment within the originally furnished system and the development of the ATCOR plan to proof-test this equipment prior to delivery at the site. Results of this pre-testing, and a comparison between pre-tested conditions and the actual in-plant start-up tests are presented.

Development of improved instrumentation and mechanical modifications which enhance the reliability of the ATCOR/DOW process In-container Mixing System was provided as a part of this project. Test results are presented on instruments, controls and the unique method of mechanical attachment of the Mixing Head to the solidification container.

BACKGROUND FOR RETROFIT DECISION

Quad Cities' original solidification system was a G.E. cement drumming system, which is still in use. To supplement the drumming system, a urea formaldehyde liner system was chosen and subsequently retrofitted to a DOW system. Shortly thereafter, urea formaldehyde was disqualified as a solidification media by the Nuclear Industry. It was decided to use a system utilizing Dow Binder 101 (a modified Vinyl Ester Resin) as its principle solidification media which is cured by the addition of a catalyst and promoter. The final product results in minute droplets of liquid waste dispersed within a continuous matrix of cured resin.

The system, designed and supplied by Dow Chemical Company, interfaced with some existing equipment supplied with the original UF system. The DOW equipment included a Mixing Head with TV, a high level detector and modification to the existing control panel. The system was designed to fill fifty (50) cubic foot containers suitable for shipment in five casks owned by Commonwealth Edison. Later, due to the materials of construction, the utility's casks were denied recertification by the NRC for shipping radwaste. At this point, Chem-Nuclear Systems, Inc. was contracted to provide mobile solidification services which continued for approximately 8 months. The utility, preferring to have its own in-house system, contacted ATCOR in early 1981 to retrofit its system to accept large, cost effective containers. The major design criteria for the system was to solidify waste with the Dow binder within the largest container compatible with existing certifiable casks.

PROPOSED SYSTEM DESIGN

The equipment provided by ATCOR was required to interface with Quad Cities' existing Dow System Binder and additive supply lines as well as plant specific layout restraints. ATCOR's scope of supply included the following major assemblies:

- Portable In-Container Mixing Head
- Permanent Hydraulic Supply Skid
- Air Supply Panel
- Control Panel
- Compatible Liner

GENERAL SYSTEM ARRANGEMENT AND OPERATION

The system general arrangement is shown on Fig. 1. Solidification processing is performed within a truck bay. A trailer mounted cask, pre-loaded with a liner is positioned within the truck bay. The liner is supplied with a disposable mixing blade assembly and lugs for engaging the Mixing Head. The Hydraulic Supply Skid for the mixing motor is located outdoors and is hard piped to the truck bay wall. At the wall, they interface with the Mixing Head Hoses. The Control Panel is remotely located in an area adjacent to the truck bay.

The Mixing Head handled via the truck bay overhead crane is lowered to the liner mating the mixers bullet nosed drive shaft with the mixing blade shaft, the locking devices are aligned and engage the liner when activated from the control panel. The waste and chemicals are added to the liner, mixed and monitored until they are solidified. Prior to remote disengagement of the Fill Head, solidification may be verified

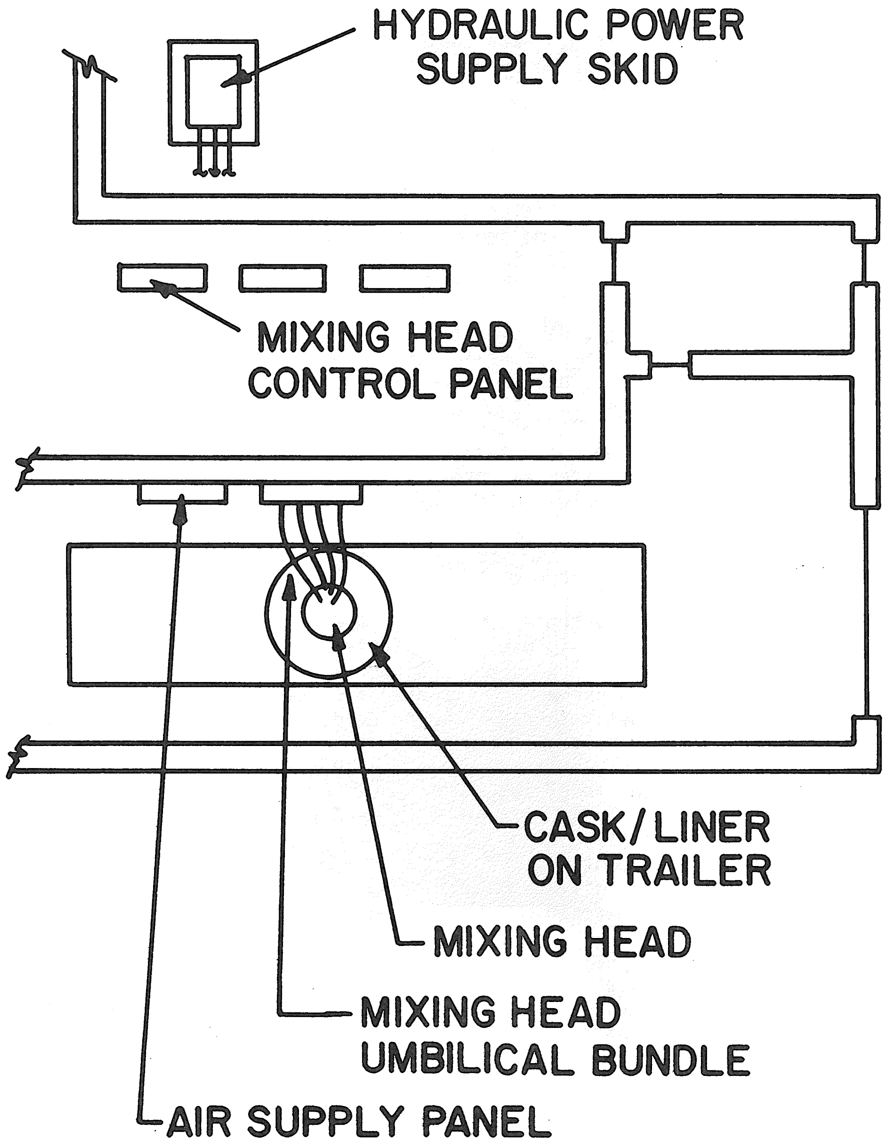

Fig. 1. System General Arrangement.

by a remote probe visible on the control panel TV monitor.

DESIGN VERIFICATION PRIOR TO FABRICATION

Prior to starting the design phase, ATCOR, its parent company Chem-Nuclear, and the DOW Chemical Company, agreed to perform a full scale test at DOW's Larkin Laboratory approximating viscosities and volumes anticipated at Quad Cities. A 195 cubic foot liner was chosen for the test, although a 170 cubic foot liner would actually be used at Quad Cities. Also used was a hydraulic power supply driven by a 40 HP electric motor with a 24 HP hydraulic motor mounted on Chem-Nuclear's R&D Mixing Head. To simulate waste material, worse case condition, Powdex Resin was used.

The following test criteria was established to verify the Design/Process:

1. Verify the liner design would form an emulsion and provide sufficient mixing action with highly viscous material.

2. Verify that sufficient power is available to maintain the proper mixing speed in a full liner.

3. Verify that sufficient power and torque is available to resume proper mixing speed from a standing start.

The simulated waste was mixed with the binder at a volume ratio of 2:1 utilizing the full liner capacity. Catalyst and promoter were not added since mixing action, as opposed to solidification, was being tested. The mixing unit maintained a constant RPM and easily resumed speed from a standing start. Upon completion of this test, it was concluded that the preliminary design met the required design parameters. Both the liner design and mixing performed properly. The liner mixing blade design maintained a vortex and sufficient mixing action throughout the procedure. Additionally, mixing was stopped for an hour and the mix was allowed to remain static and cool. A sample of the mix was taken and the viscosity was determined to be slightly higher than required. When mixing was resumed at the higher speed, no problems were encountered.

Based on the preceding test, recommendations were made to further improve the mixing characteristics by increasing the diameter of the liner mixing blades and lowering the bottom blade. An increased safety factor was also added into the system's motor for the Mixing Head to insure that all possible operating conditions could be met.

DESIGN FEATURES

Compliance with ALARA guidelines is always a design parameter. To negate manual disengagement of the Mixing Head from the full liner, three remotely operated clamping/anti-rotation devices were incorporated. Pneumatic cylinders mounted on the Mixing Head mate with lugs provided on the liner. These devices are remotely disengaged by the operator at the control panel. This feature significantly reduces personnel exposure incurred by manual methods previously used.

Continuous level monitoring is provided at the control panel and an alarm indicates preset binder and waste levels plus container high level. A redundant device provides a high-high level (emergency shutoff) alarm. Both level systems operate via pneumatic pressure differential and have proven very accurate during both pre-testing and actual field use. Closed circuit TV provides direct internal monitoring of the container at the control panel. Direct viewing is provided for the addition of media, the mixing vortex and the solidification verification probe upon completion of the process. A TV light source is externally mounted and beamed into the container through a light pipe.

For ease of maintenance and decontamination, all Mixing Head components may be individually removed for repair or replacement.

The Mixing Head has been designed such that, with minimal modification, it may accommodate processing a wide variety of binder types, waste types and container sizes. Liner sizes in excess of 200 cubic feet do not appear practical due to mixer motor power requirements, physical size restraints and cask/radiation limits. Figures 2 and 3 show the Mixing Head general arrangement.

DESIGN VERIFICATION PRIOR TO SHIPMENT OF SYSTEM

To "debug" the system prior to shipment, the equipment was assembled and operated. A liner destined for Quad Cities was diverted for use during the test period. As a result of mating the liner and Mixing Head, it was determined that a more substantial interface was required. The clamping/anti-rotation device was modified by increasing the pin diameter at the point of interface and a smoother lead in created for ease of remote engagement/disengagement. Due to schedule restraints, water was used during testing of the mixing motor, blade assembly speed and level detectors. Levels manually measured at rest and during mixing were indicated acceptably on the control panel. Mixer speed indications were also proven reliable. Mixing with water created more splashing than anticipated using the actual waste and additives. The splashing did, however, indicate a leak in the Mixing Head access door. The door was modified by relocating its clamping points and increasing its gasket thickness. The addition of water into the liner and the mixing vortex were successfully monitored using the TV system. Testing prior to delivery proved to be a reliable design verification. Further, inviting the customer to observe the final test enabled them to acquire familiarity with the equipment before processing waste on-site.

CONCLUSION

To date, six liners have been processed at the Quad Cities Nuclear Station using the ATCOR designed Mixing Head. Processing problems have been minor and readily resolved in the field.

With the proper technical interface between the utility and its suppliers, system retrofits are successfully accomplished at reasonable costs without affecting power production. In this case the cooperation provided by Commonwealth Edison, DOW Chemical Company and Atcor Engineered Systems, Inc. transformed a difficult task into a technological and operational success.

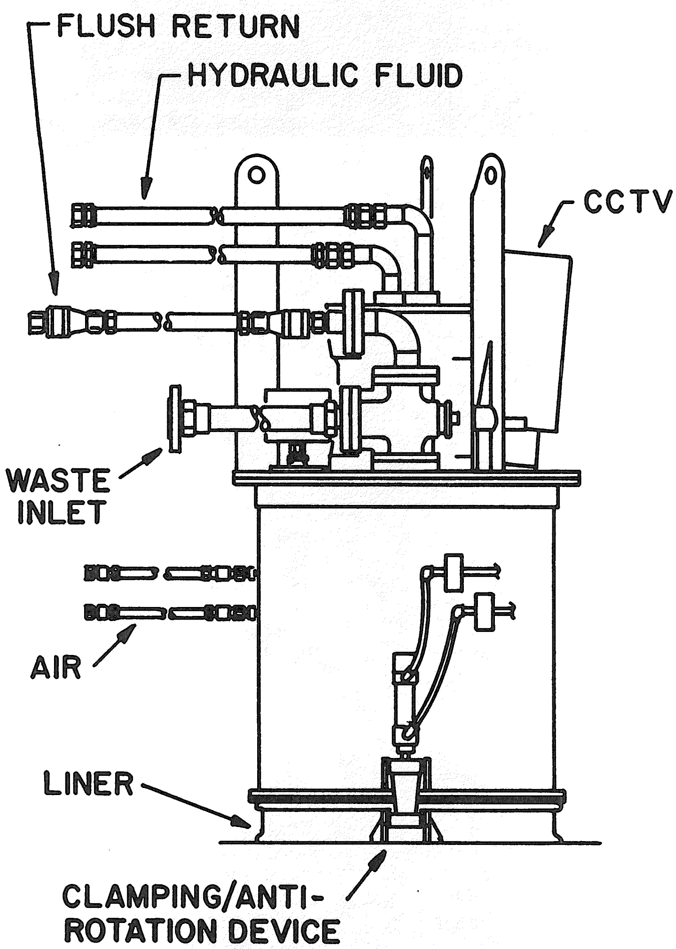

Fig. 2. Mixing Head General Arrangement.

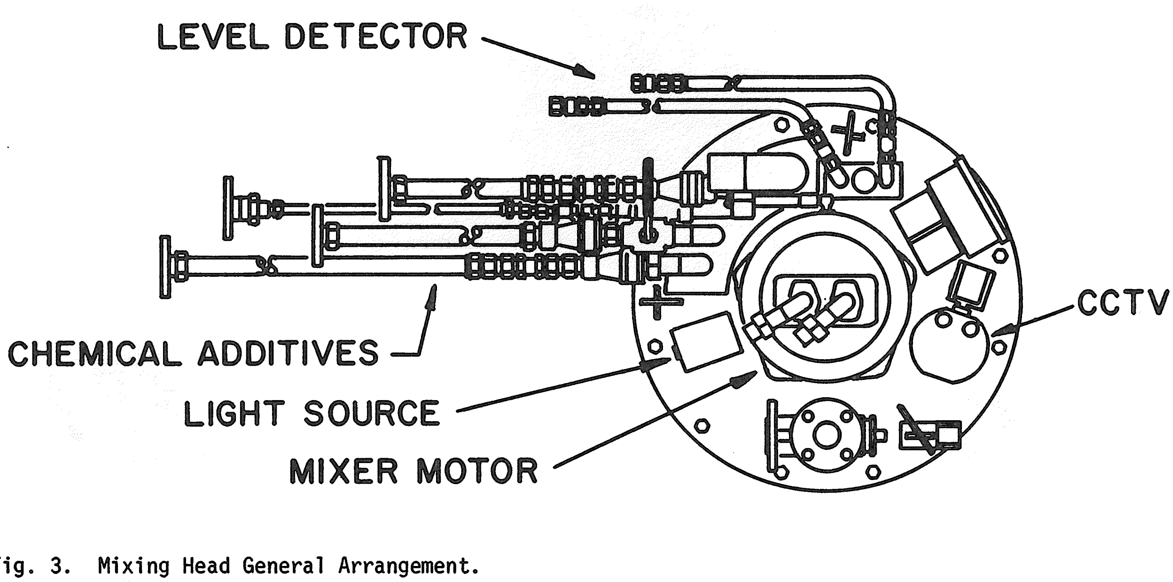

Fig. 3. Mixing Head General Arrangement.