CHAPTER XI
CAST IRON SOIL PIPE FOR CONDENSATE DRAIN LINES

Condensation and recovery (for disposal) of treated water is common to high-pressure steam systems in many industrial plants. Return of reusable water to the power house — or its drainage to a ditch, pond, or sewer — is handled through gravity systems that must be able to withstand condensate temperatures from 60°F up to 190°F. The piping used in these systems is traditionally made from stainless steel, carbon steel, or a metal alloy, because the aggressive condensate rapidly corrodes ordinary mild steel pipe.

At several manufacturing plants owned and operated by the Du Pont company, both exposed and underground gravity condensate drain lines were traditionally made of stainless steel piping. In an effort to save the high materials cost of this coated and wrapped alloy piping, a major evaluation of alternate materials were conducted at Du Pont's Engineering Test Center near Wilmington, Delaware. The evaluation program extended over a 14-month period and involved tests of three different types of fiber-reinforced plastic piping (joints made with adhesives) and cast iron soil pipe joined with neoprene compression gaskets. Results showed that the cast iron pipe gave satisfactory performance for the full test period, equivalent to the best of the plastic pipes. In addition, because of lower material costs and ease of installation, the cast iron soil pipe proved far more economical than any of the plastic systems. Details of the evaluation program are reviewed in this chapter.

ASSEMBLY AND INSTALLATION OF MATERIALS TESTED FOR USE IN CONDENSATE DRAIN LINES

The materials tested for use in condensate drain lines are shown in Figure 1. The cast iron soil pipe system tested was joined with neoprene compression gaskets, developed mainly for use with industrial and residential drain, waste and vent piping. Prior to the introduction of neoprene joint seals, cast iron soil pipe, despite its corrosion resistance, had not been used in steam conden-

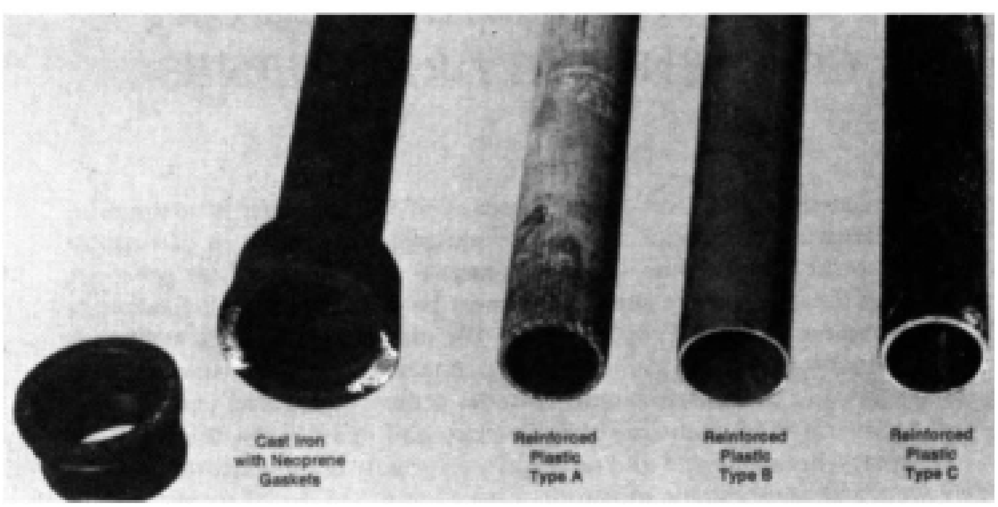

FIG. 1 — Materials Tested for Use in Condensate Drain Lines

sate drain lines because the lead and oakum joints traditionally used would not remain leak-free under the extensive thermal fluctuations encountered. The three commercial brands of fiber-reinforced plastic pipe tested were all in the same materials cost range, and all employed an adhesive system for making joints. Major differences among the three were in outside surface finish and wall thickness.

Assembly Procedures and Comparative Costs

The amount of joint preparation for the plastic pipes varied with the type involved. The rough O.D. of one had to be removed using a drum sander, equipped with a dust collector for safety, thus increasing its preparation time. All three plastic pipes required strict cleanliness to obtain a satisfactory joint. As a minimum, surfaces had to be sanded, solvent wiped and kept dry. In cold weather, the plastic pipe joint and adhesive had to be heated above 60°F before assembly. Joint cure time was also dependent upon temperature. Above 80°F, the adhesive had to be kept cool or mixed in very small quantities to prolong pot life. Without these precautions, in warm weather, adhesive pot life would have been as short as five minutes. Saddles were used to connect the water, steam and condensate lines to the plastic pipes. This was quickly done, except in the case of the type with the rough O.D., which required more than twice as long to connect as the other two.

Some joints in the cast iron system were assembled dry; others were made using the recommended combination lubricant/adhesive. No problems were encountered during installation, and joints were made quickly and without difficulty. Previous experience with this system had proven that installation was practical at any temperature or in any weather condition in which a man would be willing to work.

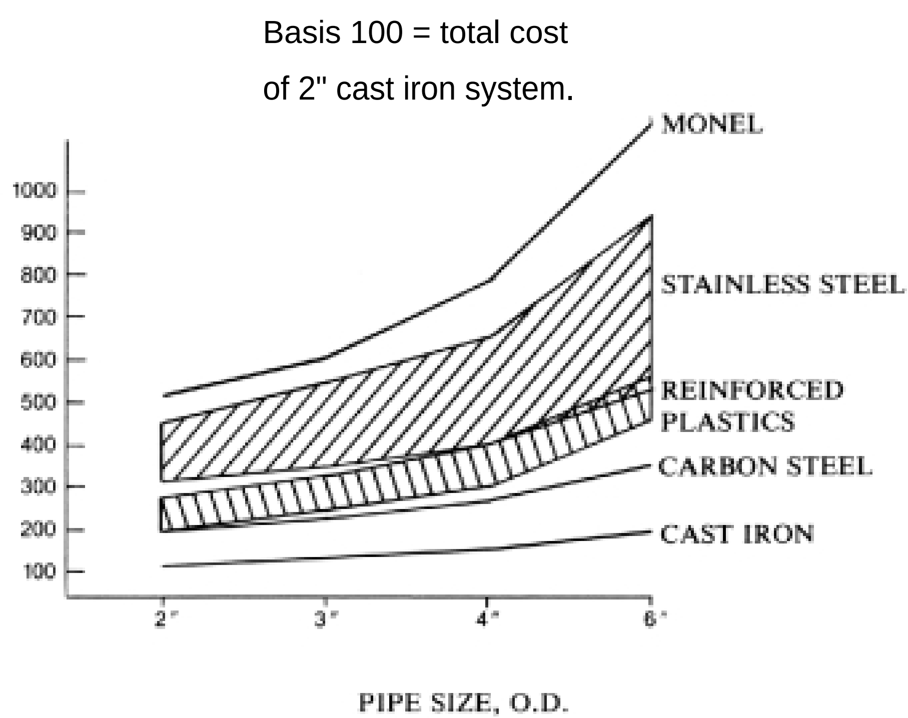

CHART 1 — Comparative Costs of Steam Condensate Test Systems

Upon completion of the test assembly, it was apparent that a significantly lower cost had been incurred with the neoprene-gasketed cast iron soil pipe than with any of the fiber-reinforced plastic pipes. (See Chart 1.) This was primarily a result of the negligible joint preparation that was needed to assemble the cast iron system compared to the strict cleanliness and assembly temperature requirements for the plastic pipe.

DESCRIPTION OF TEST RIGS AND CHRONOLOGY OF TESTING PROCEDURES

Test Rigs

One system of each test material was assembled from 2 inch diameter pipe, with a joint located approximately every three feet along the line. Each rig consisted of a 9 foot-high stack and a 30 foot-long horizontal run, with a 90° turn approximately midway in the run. (See Figures 2 & 3.) The lower end of each system was left open. A ball valve was mounted at the top of each stack to provide a slight pressurization on the system. (In actual service, the upper end of a gravity drainage system's vent stack would be open to the atmosphere.)

Separate water, steam and condensate inlets were provided near the top of each stack. Initially, cold tap water was supplied for occasional manual thermal cycling. (This was changed part way through the test to warm water, and the system was equipped for automatic thermal cycling.)

Steam was supplied from a 25 psi regulator. An impulse type trap was used for condensate supply, with additional water injected upstream to increase the flow to approximately 2 gpm per section. Two thermocouples were installed in each line to measure pipe-wall temperature. One was located in the first 2 feet or the horizontal run, with the second approximately 12 feet downstream of the first.

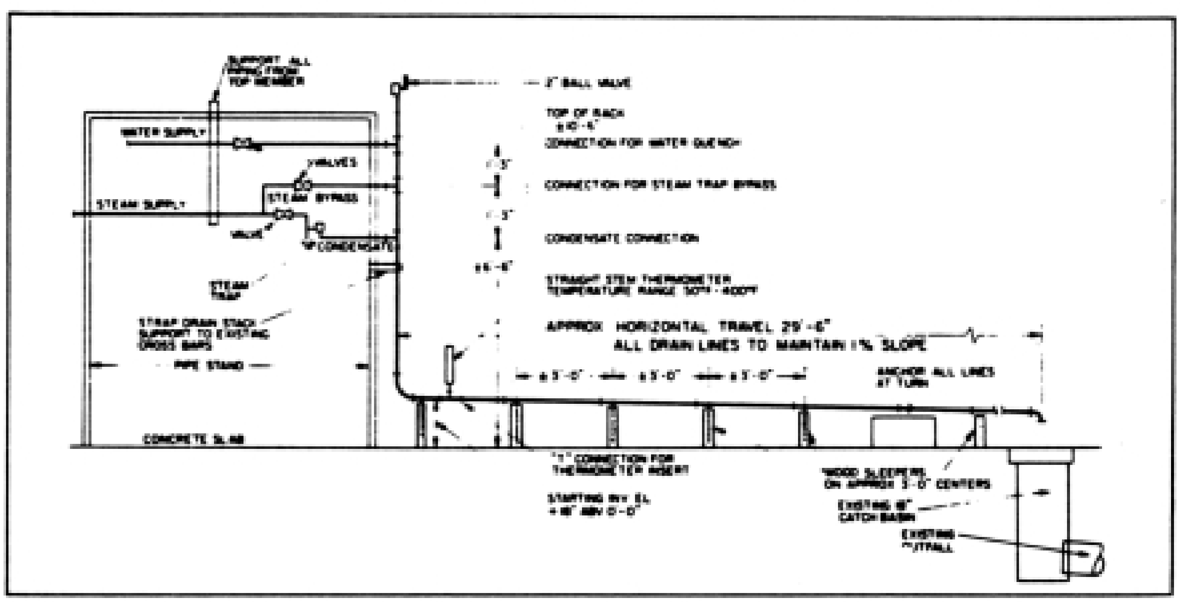

FIG. 2—Details of Steam Condensate Test Systems

Testing Procedures

The test rigs were put into service, and after two months of operation, all test lines were insulated with 1”-thick fiberglass with an asphalt-impregnated asbestos overwrap to maintain satisfactory pipe temperature during the winter weather and to simulate underground burial.

During the first five months of the test, heat in the lines was supplied by the condensate water injection system. Pipe wall temperatures averaged 145°F before insulation, and 165°F after. For the next two months, only the steam condensate was used. Pipe temperature dropped to 120°F during that time. Then the cold water supply line to the stack was replaced with a warm water discharge from another test. This pumped 110°F to 120°F water into each stack for two minutes of every eight. At that time, the introduction of continuous low-pressure steam to each stack was also begun. Maximum pipe temperatures were then approximately 185°F. These decreased to approximately 145°F (in the plastic) and 160°F (in the cast iron) during the water flush cycle. Cycling rate was approximately one cycle per hour.

After nine months, the systems were modified to cycle from cold water (60°F) to atmospheric steam (212°F) in alternative 10 minute intervals. Pipe temperatures recorded by the thermocouples ranged between 90°F and 200°F in the cast iron pipe to 85°F and 185°F in the plastic pipe. Three thousand cold-hot cycles were run under these conditions.

The system was again modified a month later to a cold water (65°F), 5 psig steam (225°F), 10 minutes “on,” 10 minutes “off” cycle. Recorded temperatures ranged between 90°F and 190°F in the cast iron, and 85°F and 175°F in the plastic pipe. A split in an elbow of one of the plastic pipes was detected during the first pressure cycle. After 300 cycles at this condition, the same material had an adhesive failure at an elbow joint. The pipe run was then removed from the testing cycle. Cycling was then continued on the remaining systems to a total of 1500 cycles. (See Chart 2.)

CONCLUSIONS AND RECOMMENDATIONS

The cast iron and two types of plastic pipe passed all tests. One type of plastic pipe failed in an adhesive joint. The elbow fitting might have cracked during the heat cycling or pressure cycling. Though considerably lower in materials cost, the cast iron pipe using the neoprene gasket performed as well as the plastics in all tests that were considered realistic in a condensate gravity drain line. It was also the easiest and least costly to assemble.

In summary, the neoprene gasketed cast iron soil pipe and two of the plastic candidates passed all test requirements. All three materials were substantially less expensive than metal alloy piping, but both materials and installation costs were far greater for the plastics than for the cast iron. This was because proper assembly of the plastics require special, labor-consuming preparation of joints. Unfavorable weather and low temperature conditions intensified difficulties of making the adhesive-bonded plastic piping joint.

Upon completion of the tests and full evaluation of the results, Du Pont’s Engineering Department issued the following recommendation to its operating plant personnel: “Recommendation that cast iron soil pipe (ASTM A74, XH or SV) with neoprene compression-type gaskets (ASTM C564) be considered as a material of construction for underground, gravity flow, nonpressure condensate drainage systems. The only design qualifications shall be that the system be properly vented to free atmosphere."

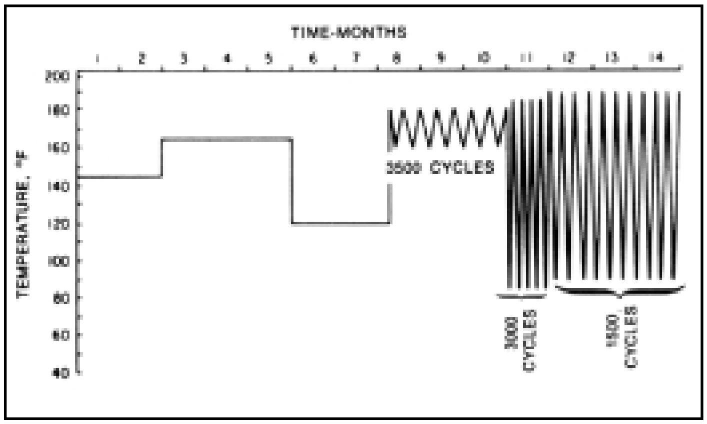

CHART 2 — Pipe Wall Temperatures During Test Period