Customers and Applications

Impedance systems heat a wide variety of gases, liquids and viscous materials which are stored, pumped and processed in many different industries and applications. Impedance heating can be used in three basic ways:

Cold Start: Heat is applied to increase fluidity of static, viscous materials so they can be pumped. Typical materials include asphalt, molasses and heavy fuel oils.

Maintain Temperature or Pipe Tracing: Heat is applied to a liquid or gas flowing through a pipe to offset heat losses. Typical applications include freeze protection or maintaining the fluidity of viscous materials.

Temperature Rise: Heat is applied to a liquid or gas flowing through a pipe in order to raise its temperature between the inlet and outlet of the heated pipe. Typical applications include heating corrosive liquids or high temperature process air.

A partial list of customers and applications are shown below.

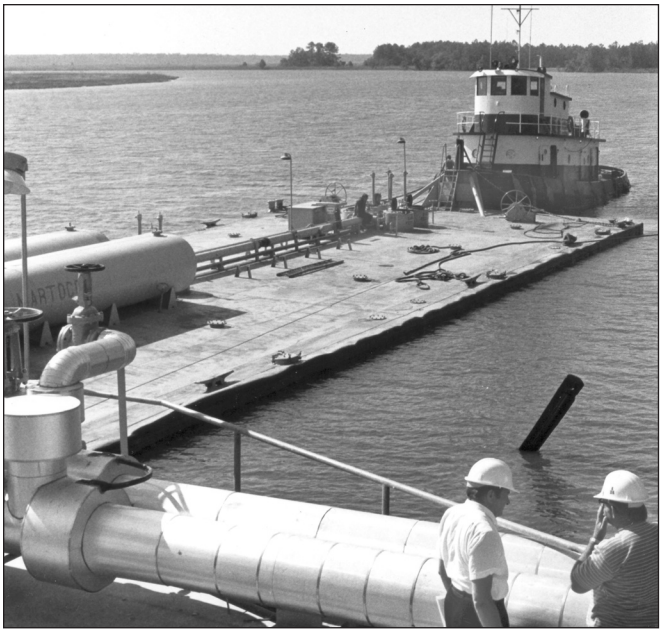
CUSTOMER	MATERIAL HEATED	TEMP (°F)	PIPE LENGTH (FT)
Allied Chemical Corp.	Coal Tar Pitch	450	131
Allied Fibers Corp.	Superheated Steam	1040	70
Aluminum Co. of America	Pitch	170	1155
American Hoechst Corp.	Polypropylene	400	22
Amoco Oil Co.	Fuel Oil	280	891
Amoco Oil Co.	Zinc Chloride	700	53
Arco Oil & Gas Co.	Crude Oil	150	15700
Atlantic Richfield	Salt Water	40	802
Barnard & Burk	Sulphur	265	70
Bethlehem Steel	#6 Fuel Oil	280	891
Bouligny Co.	Superheated Steam	845	34
British Petroleum Alaska	Water	40	611
Brown & Root Inc.	Crude Oil	50	1270
Catalytic Corp.	Liquid Pentasulfide	752	2
Celotex Corp.	Asphalt	400	1760
Certain Teed Corp.	Asphalt	480	52
Chemtex Inc.	Polymer	536	52
Chevrolet Motor Div.	Catalyst	70	770
Colgate Palmolive Inc.	Sulphur	300	165
E.I. Dupont	Process Gas	575	170
Emery Industries	Stearic Acid	160	370
Ethyl Corp.	Powdered Catalyst	450	53
Exxon Research & Engineering	Heavy Fuel Oil	950	552
Exxon Synthetics Inc.	Coal Slurry	370	558
Fisher Scientific Co.	Resin & Hardener Mix	194	40
Fortifiber Corp.	Asphalt	500	250
Foster Wheeler Corp.	Paraffin	60	1020
H.K. Ferguson	Pitch	735	100
Hershey Foods Corp.	Chocolate	110	377
Honeywell	Air	1200	114
Inland Steel Co.	Fuel Oil	160	8500
Intalco Aluminum	Air/Tar Mixture	500	52
International Paper	Wax	185	520
Kaiser Aluminum Co.	Coal Pitch	380	500
Kitchens of Sara Lee	Nulomoline	100	325
Koppers Co.	Enamel Filling	375	85
Layton Engineering	#6 Fuel Oil	125	550
M & M Mars Co.	Chocolate	120	1400
Medusa Cement Co.	#6 Fuel Oil	150	700
Mobil Pipe Line Inc.	Wax	145	93
Monsanto	Montar	752	230
N.L. Industries	Magnesium Chloride	1300	95
National Starch & Chemical	Wax	210	300
National Starch & Chemical	Wax/Resins	100	1400
Nestlé	Chocolate	110	263
Pillsbury Haagen Dazs	Sweeteners	120	180
PolyOne Elastomers & Performance Additives	Oil	180	350
Procon, LTD.	Sulphur	285	890
Rohm & Haas	Process Vapor	1100	26
Shell Chemical Co.	Process Fluid	500	41
Sherwin Williams, Inc.	Pitch	500	140
South Carolina Electric	Sulphur	110	1350
SPEC Process Engineering & Construction Inc.	Isocyanate	120	400
Stauffer Chemical Co.	Phosphorous Pentasulfide	707	30
Sun Oil Company	Sulphur	290	485
Tennessee Eastman	Polymers	320	1165
Trimount Bituminus	Asphalt	325	425
Union Electric Co.	Wax	212	612
Upjohn	Isocyanate	120	476
Vulcan Material	Caustic	750	360
Western Electric Co.	Thermoplastic Rubber	300	900
Yabucoa Sun Oil Co.	Pitch	400	2300

Impedance Heating Applications

Power Generating Utility

Application: To maintain heavy fuel oil at 140° F and facilitate pumping from barges to storage tanks and return lines. The application required cold start recovery capabilities to heat up the fuel oil in case of station shut down. Pipe size diameters ranged from 10" to 24" with a combined pipe length of almost two miles. Impedance heating was selected because critical importance was placed upon system reliability, maintenance and operating costs.

Design: Seven impedance heating systems were required. To conserve heat, pipe lines, gaskets and flanges were covered with 2" of insulation and sheathed with 16 gauge aluminum.



Impedance heating used to facilitate pumping of fuel oil from barges to storage tanks at power generating utility.

Food Processing

Application: To maintain the temperature of chocolate and sweetener at 120° F as it flows through 16 gauge, sanitary 304 stainless steel tubing lines. Impedance heating was selected because of the temperature sensitive characteristics of the material and the importance of uniform temperature control to the quality of the product. Pipe lengths for different lines varied from 128 feet to 420 feet. The sanitary environment required frequent washdown of the control panel.

Design: Three individual impedance heating systems were required, rated 1.5, 2 and 3 KVA. Standard on-off control with operational RTD input was selected. Stainless steel, NEMA 4X control panel enclosures with a viewing window to monitor actual process variables were supplied to meet the frequent washdown requirements.

Metal Processing

Application: To heat a mixture of air, water vapor and tar particles up to 400° F at a flow rate of 5,750 lbs/hr. Ten inch diameter stainless steel ducts were used in the first phase of the process where the mixture was heated up to 400° F. Carbon steel ducts were used in the second phase of the process to maintain the final temperature. Impedance
heating was the most cost effective method for this application which included one additional requirement of heating the duct work up to 500° F during a cleaning phase where residual tar on the duct walls melt, allowing it to simply flow out of the duct work.

Design: Three individual impedance heating systems rated 36, 171 and 176 KVA were used in this application. Full SCR controls were used for each system to provide precise temperature control. Special weld terminals were also supplied due to the high secondary transformer currents.

Plastic Processing

Application: To control, monitor and heat to temperature within 16 hours, a 4,800 foot, 2" schedule 40, 304L stainless steel pipe containing a sludge mixture. The impedance heating control panel needed computer interface with auxiliary outputs for alarm indication.

Design: Six identical 11 KVA impedance heating systems were supplied for this job. The solid-state proportional control panel was capable of remote signal input and temperature indication and included ammeters, voltmeter and auxiliary control circuit source. Under actual operating conditions, the impedance heating system exceeded the application requirements by providing a recovery time of only 14 hours, which was of critical importance to the process, allowing greater production rates.

Impedance Heating Applications

Chemical Processing

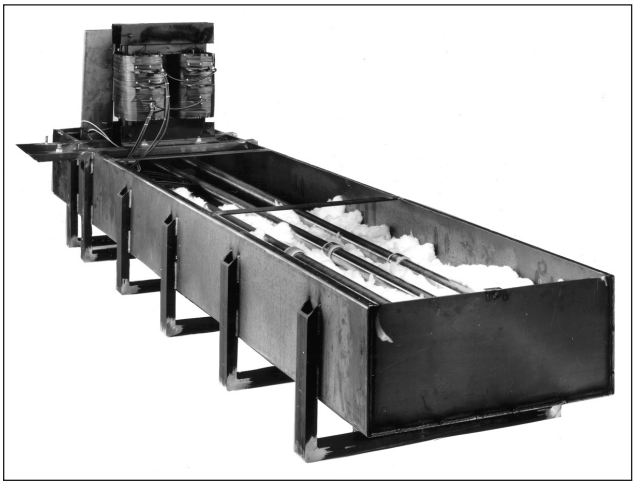
Application: A highly corrosive material must be heated through a 630° F temperature rise with a flow rate of 160 lbs/hr. Conventional process heating methods were too costly and could not withstand the high temperature corrosion for any reasonable period of time. Impedance heating provided the answer.

Design: Customer supplied, heavy wall, Inconel pipe became the heating element and transporting device in this impedance heating system. A midpoint connection system was selected to eliminate the need for electrical isolation at the pipe ends.

Test Equipment

Application: To preheat high temperature air from 800° F to 1200° F at a flow rate of 20 lbs/min. Impedance heating was selected over the more conventional direct heating methods because of the low flow rate and high outlet temperature. A low pressure drop was also a requirement of the application. The impedance heating system easily met this requirement since the pipe became the heating element, offering no obstruction to the high temperature air flowing through the pipe.

Design: One 75 KVA impedance heating system was used. The design was a completely packaged unit including an Incoloy pipe in a multipass configuration, transformer, control panel with full instrumentation and high temperature insulation.



Packaged impedance heating system for test equipment application. (System cabinet enclosure was removed for photography.)

Aerospace

Application: Constant 600° F air at pressures up to 3,000 psi was needed at three different locations, including two wind tunnels and one model preparation area. Distances from the air storage area to the point of use ranged from 100 ft. to 200 ft. Impedance heating was chosen as the most cost effective way of preheating the piping from the storage tank to the three use points.

Design: Initial heating of the air in the storage tank was performed by two 400 KW resistance heaters. Three individual 20 KVA impedance heating systems were then used to maintain the temperature of the air as it passed through the schedule 160 carbon steel piping which was selected because of its suitability for such high pressure applications. To minimize heating costs, all above ground piping was thermally insulated and some piping was buried underground with a fiberglass polyester weatherproof coating.

Impedance heating used to heat high temperature, high pressure air for aerospace application.

Impedance Heating Applications

Asphalt Processing

Application: To heat carry-off piping leading from the asphalt plant to storage tanks. Impedance heating was chosen as the most cost effective way to heat and maintain the temperature of 350 tons of asphalt at 100° F.

Design: A conventional impedance pipeline heating system was used for the carry-off piping. The transformer and control panel were located away from the storage area for easy access.

Impedance heating used to maintain temperature of 350 tons of asphalt.

Aircraft Manufacturing

Application: To heat 1200 psig compressed air flowing at 75 lbs/hr from ambient to 1200° F for purposes of testing aircraft components. Several independent test cells required the equipment to be portable. An impedance heating furnace was chosen as the most cost effective and reliable means of heating air at these elevated temperatures and pressures.

Design: One 23 KVA, 480V single-phase impedance heating furnace was supplied with casters to allow for relocation of the furnace to the various test cells. The design was a completely packaged system with Incoloy 800 piping, mounted in an insulated stainless steel housing, and prewired to the system transformer and control panel.

Portable impedance heating furnace for testing aircraft components.

Application: To heat 1800 psig compressed air flowing at 240 to 600 lbs/hr from ambient to 1200° F for purposes of testing aircraft components. The customer's existing power feed required the utilization of three-phase power.

Design: A single 120 KVA, 480V three-phase impedance heating system was supplied with three identical zones to accept the three-phase power supply. The design was a completely packaged system with Incoloy 800 piping, mounted in an insulated stainless steel housing, and prewired to the system transformer. The control system was supplied for remote mounting in the customer's control room.

Three-phase impedance heating furnace for testing aircraft components.