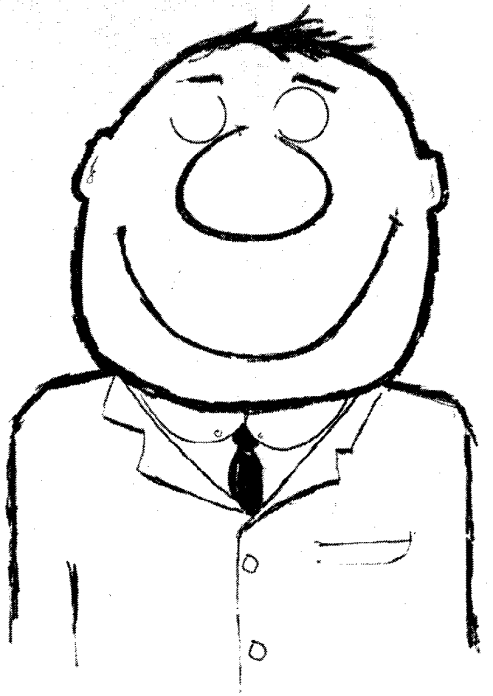
TWO HEADS ARE BETTER THAN ONE . . .

. . . SO MAY WE "BORROW" YOURS FOR A FEW MOMENTS OVER A CUP OF COFFEE?

We have some valuable information on low-pressure, liquid phase indirect heating for **someone** in your company — and we thought you might be able to **help** us find him!

The information in this packet tells all about the safety, economy and maintenance advantages of using Monsanto's THERMINOL fire-resistant heat transfer fluid. It's a good possibility that your company is involved in one — or more — projects right now that could benefit from the use of THERMINOL.® But we must get our information packet into the hands of the man who "knows" before we can start solving problems.

We think the man we're looking for in your company is a Process Design Engineer or a Plant Engineer . . . but we're not sure. We would deeply appreciate your assistance in helping us answer this question: WHO IS YOUR MAN THAT "CARES" ABOUT HEAT TRANSFER AND INDIRECT HEATING?

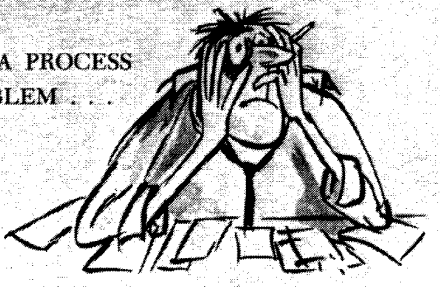


Shall we lift the dimes and have a cup of coffee as we talk it over? Thank you!

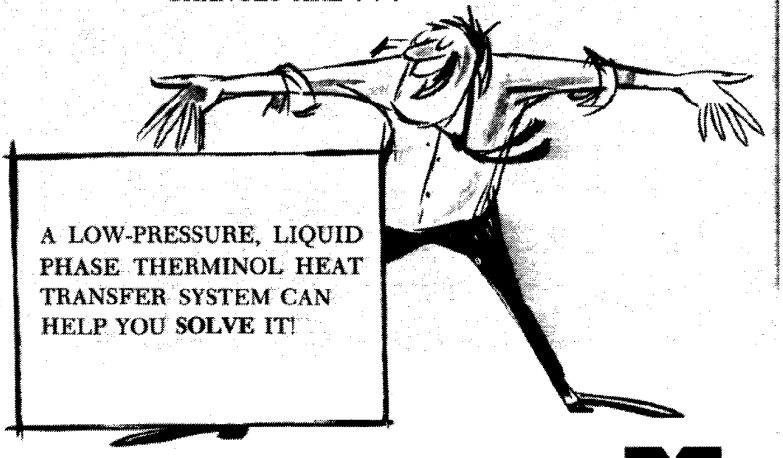
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WATER_PCB-00017547

IF YOU HAVE A PROCESS HEATING PROBLEM . . .



CHANCES ARE . . .



A LOW-PRESSURE, LIQUID PHASE THERMINOL HEAT TRANSFER SYSTEM CAN HELP YOU **SOLVE** IT!

Monsanto

TOWOLDMON0033079
WATER_PCB-00017548

"QUESTIONS AND ANSWERS. . . "

. . . Most asked about THERMINOL liquid heat transfer fluids and fluid systems. The questions outlined here are intended to "anticipate" many of the thoughts that immediately come to most people's minds in a "first-discussion" of THERMINOL.

The answers are very brief and pointed -- but should serve as a surface "preview" of indirect heating with THERMINOL.

1. Why should I use indirect heating via a heat transfer liquid?

   The two alternatives most used have definite drawbacks. Direct firing often produces uneven heating, difficulty in temperature control and can be hazardous when heating combustible materials. Pressurized vapor, either as steam or organic vapors, requires high pressure construction and accompanying greater expense.

   All liquid forced circulating systems such as THERMINOL FR offer:

   a. No condensate return problems.

   b. Fast response to load changes and temperature control to $\pm 2^{\circ}F$.

   c. Minimum loss of heat from radiation due to smaller piping and valves.

   d. Predictable heat transfer--no variation due to sub-cooling of condensate.

   e. Heating and cooling can be performed by a single medium.

2. Why is THERMINOL FR unique compared to other, all liquid, indirect heating media?

   THERMINOL FR is fire resistant -- is the only heat transfer medium so listed with Underwriters' Laboratories, Inc. It is fully recognized by the Factory Insurance Association as well as other agencies concerned with industrial fire protection. THERMINOL FR will not support combustion.

TOWOLDMON0033080
WATER_PCB-00017549

3. What is THERMINOL FR?

Chemically speaking, THERMINOL FR fluids are chlorinated biphenyl compounds.

4. Which THERMINOL FR is "right" for my application?

There are three THERMINOL FR products. The major differences of which involve low temperature fluidity and boiling points. Usually THERMINOL FR-2 is best. If cooling is part of the system, THERMINOL FR-1 may be more desirable. Only for special applications, a high boiling point may be necessary and THERMINOL FR-3 would be used.

5. Does THERMINOL have heat transfer properties equal to or better than other liquid heat transfer media?

Yes -- and heat transfer curves available from Monsanto demonstrate this. When a comparison is made on a volume basis of the specific heat (heat capacity) of THERMINOL FR with that of other organic liquids, for example, THERMINOL FR is comparable. In fact, it is superior to some fluids insofar as specific heat and other heat transfer properties are concerned.

6. How high in temperature can I go?

A bulk fluid temperature of 600°F. and a maximum film temperature of 640°F. will assure long service life of the THERMINOL FR heat transfer liquid.

7. What happens if I exceed these limits?

You can heat THERMINOL FR to about 650°F., if you design for it. The fluid will eventually increase in viscosity and have to be re-purified.

8. How do I know THERMINOL FR will perform as promoted?

In properly designed systems, THERMINOL FR will perform as promoted since all the properties important to heat transfer are carefully monitored and the product is produced to rigid specifications which guarantee these properties. THERMINOL FR is the only heat transfer medium manufactured with these "controls."

TOWOLDMON0033081
WATER_PCB-00017550

9. Why is system design important to proper performance of THERMINOL FR?

The key words are film temperatures. While the bulk fluid may be at 600°F., in improperly designed systems, either due to poor heater design or flow deficiency, THERMINOL FR can be locally overheated at the interface between the heater tube wall and the bulk flowing stream. This can accelerate the degradation of the fluid, shortening its useful life.

10. What must I look for in the way of THERMINOL FR system components?

Generally, standard high temperature, low pressure equipment made of steel is satisfactory. Heaters of the "water tube" type are preferred, but "fire tube" type heaters are satisfactory for temperatures of 500°F. and below. Centrifugal pumps with mechanical seals are recommended, and Schedule 40 piping is satisfactory. An expansion tank should be included in the system.

11. What can be done should I inadvertently overheat THERMINOL FR?

THERMINOL FR can be reclaimed and Monsanto will arrange to have your fluid processed. The charge is low and the service is rapid.

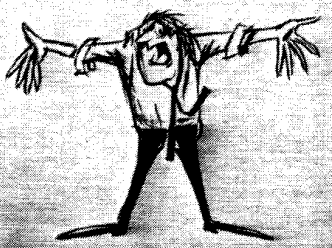
12. How do I know when THERMINOL FR Fluid should be reclaimed or replaced?

Monsanto's analytical service is available - free of charge to all THERMINOL FR customers. Or, the customer may perform simple viscosity and acidity checks himself to determine the condition of his fluid. Monsanto will afford guidance in this case.

13. What are the heat transfer properties of THERMINOL FR?

Monsanto has done considerable research to establish definite values for the heat transfer properties. These are avilable in our new THERMINOL FR Engineering Heat Transfer Data Manual, available to you upon request at no charge.

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WATER_PCB-00017551



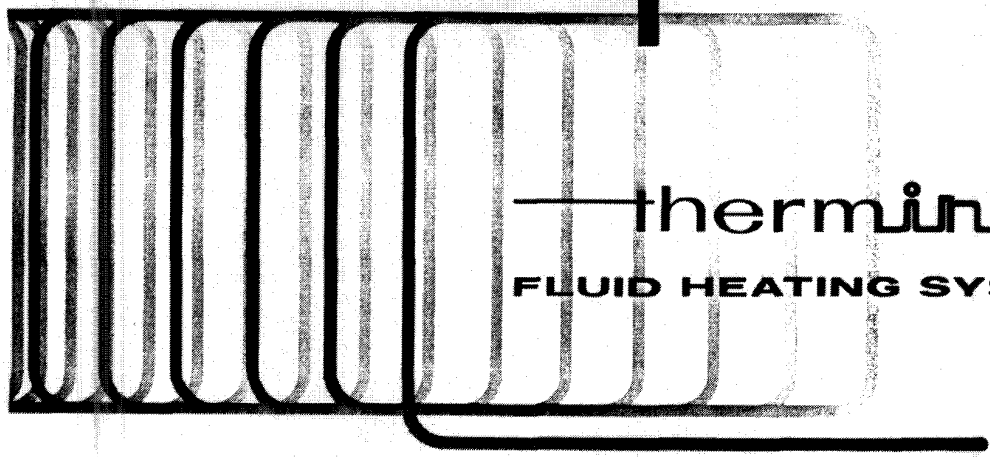
WHAT'S SO GOOD ABOUT LIQUID PHASE HEAT TRANSFER WITH THERMINOL?

This pocket contains the answer to this and many other questions most people ask when considering the installation of an indirect heating system. Of course, we can be even more specific . . .

0476115

TOWOLDMON0033083
WATER_PCB-00017552

non-pressurized
fire resistant
minimum cost



therminol

FLUID HEATING SYSTEMS

...deliver high temperature processing heat as a liquid!

Monsanto

0476116

TOWOLDMON0033084
WATER_PCB-00017553

Until recently, engineers had a limited choice of two methods to deliver processing heat: *direct firing* or *pressurized vapor*. But, in recent years, a new, third method has been developed and is gaining ever wider acceptance. It is called THERMINOL heating, and transfers heat safely, non-pressurized—as a liquid.

This non-pressurized liquid system of heat transfer is based on a series of thermally stable liquids, developed and thoroughly studied by Monsanto. Since 1957, the method has undergone extensive development by leading heating equipment designers and engineers. Today, THERMINOL FR heat transfer is used widely to provide process heat up to 600° F. with no pressurization, for a variety of uses in every major industry.

The potentially hazardous process of circulating high temperature liquids, at or above their fire point, is made safe with THERMINOL FR products. Being extremely fire resistant, they are approved by insurance carriers—are the *only* heat transfer fluids listed by Underwriters Laboratories.

The following pages describe the safety, operating advantages, and economies of THERMINOL FR indirect heating systems and show how these systems can be adapted to practically all needs for processing heat—from food cooking and resin production, to petroleum refining and space heating.



0476117

TOWOLDMON0033085
WATER_PCB-00017554

transferring heat safely . . . in liquid form

Over a dozen advantages in three areas of engineering

THERMINOL FR liquid heat transfer systems are used widely for delivering process heat because they offer the following combination of operating advantages that cannot be matched by any other method of heating.

LOWER INITIAL CAPITAL COSTS

Lighter Construction

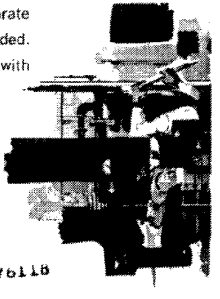
Cheaper piping

No "safety valves"

Less installation labor

Based on BTU delivered, a THERMINOL heating system serving many heat users in a large plant can often be custom made and installed at lower capital outlay than a steam system or any other system employing vapor. In a THERMINOL system, there is **no pressurization.** This means the heater, the transmission piping, and the heat-user equipment can be less costly in materials and design than equipment that must withstand high pressures.

Non-pressurized THERMINOL systems can often be installed much faster than high pressure vapor distribution systems. Gasketing and insulation are simpler; no elaborate tracer lines or multiple, high cost pressure reduction or safety shut-off valves are needed. Neither the heater, the transmission system, nor the users need be equipped with expensive monitoring and safety devices.



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safer, more dependable operation

Safety from fires

The THERMINOL FR liquids that carry heat from the heater to the use points are chemically inert, FIRE RESISTANT liquids which do not support combustion. THERMINOL FR liquids are the only heat transfer fluids tested and listed by UNDERWRITER'S LABORATORIES as fire resistant heat transfer media—and recognized by the FACTORY INSURANCE ASSOCIATION as safety fluids.

THERMINOL *offers maximum fire-resistance*

Should THERMINOL FR leak or spill—it will not propogate fire! Even when spilled into the fire box, THERMINOL FR will not feed the flame from a gas or oil burner.

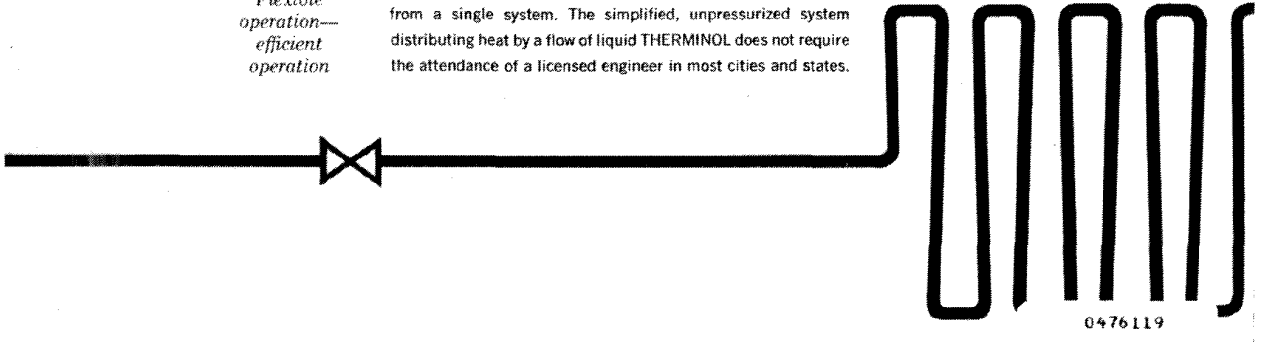
Uniform heating

THERMINOL heating systems distribute heat uniformly to the heat users. Unlike direct fired processing, there are no "hot spots"—heating is even and uniform. By simple flow-control, the temperature at various use points can be held at different levels and controlled to an accuracy of ±2°F.

Pinpoint temperature control

THERMINOL can be used for both heating and cooling. This means **maximum flexibility** and **maximum efficiency** from a single system. The simplified, unpressurized system distributing heat by a flow of liquid THERMINOL does not require the attendance of a licensed engineer in most cities and states.

Flexible operation—efficient operation



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TOWOLDMON0033087
WATER_PCB-00017556

cheaper, easier, simpler maintenance

THERMINOL *is long-lasting*

No corrosion problems

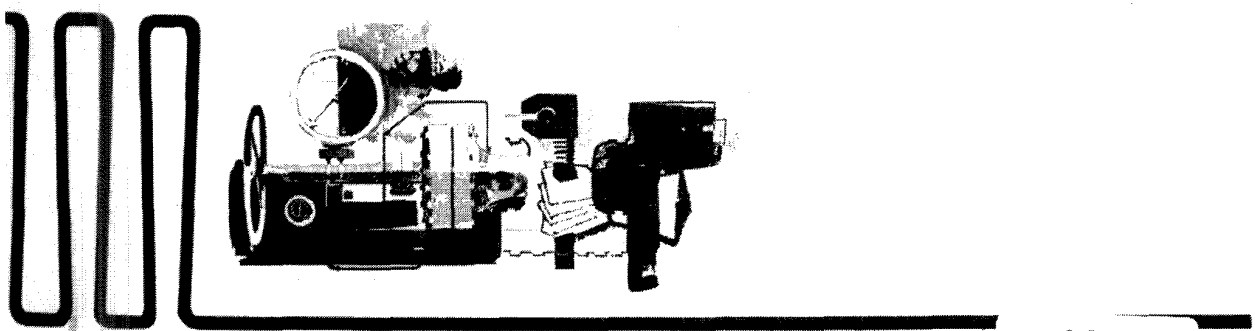
No water conditioning

No periodic "blow downs"

In a well designed heating system, the initial fill of THERMINOL will last for years. These inert liquids are thermally stable, chemically inert and non-corrosive. They are non-volatile, so "make-up" is negligible; they will not decompose in normal operation, even in contact with air, and there are no problems of scale or sludge. No treating chemicals are needed and inspection of the heat transfer fluid is infrequent.

THERMINOL systems require very little maintenance and only a tiny fraction of the attention required by a steam system.

THERMINOL does not break down from long use at 600°F. Local hot spots in certain types of heaters can shorten THERMINOL's service life. To gain the full value of THERMINOL heating—the heater and the system should be obtained from reputable firms whose past experience can help provide you with the best operating unit available.



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TOWOLDMON0033088
WATER_PCB-00017557

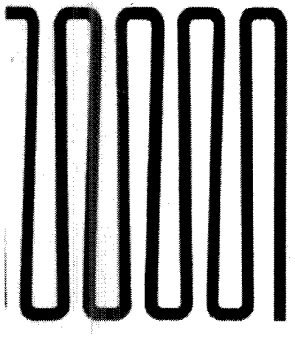
The secret of successful liquid heat transfer:

therminol

Through close association with customers in all leading industries, Monsanto became aware of the demand for new, improved heating and cooling fluids. To meet this need, a special class of fluids was developed and produced to meet the exacting specifications of the heat transfer field.

Careful engineering study and in-plant evaluation led to the present THERMINOL FR series—with controlled thermal conductivity, specific heat, thermal stability, vapor pressure and viscosity.

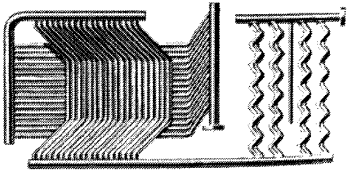
THERMINOL
is the safest, most dependable and most efficient heat transfer media available today!



THERMINOL FR-1
—low temperature fluidity

THERMINOL FR-2
—for most applications

THERMINOL FR-3
—highest temperature fluid



0476121

TOWOLDMON0033089
WATER_PCB-00017558

HERE'S WHY A therminol HEATING SYSTEM "GUARANTEES" TROUBLE FREE OPERATION...

Resistance to deterioration extends fluid service

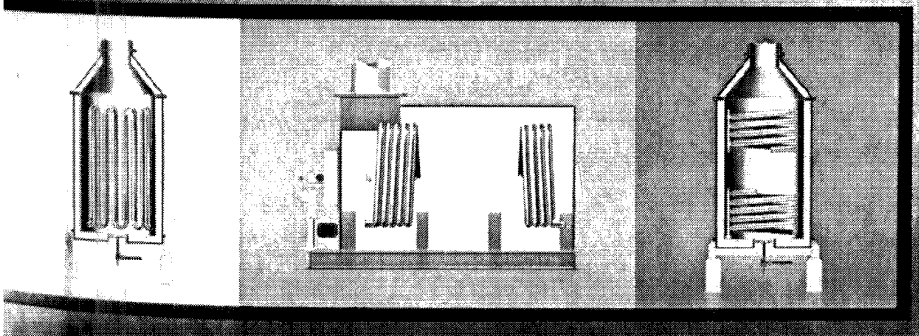
Even heating eliminates hot spots

Fire resistant for safer heating

therminol
LIQUID HEAT TRANSFER

Requires no pressurizing

Eliminates sludge, scale and corrosion



0476122

TOWOLDMON0033090
WATER_PCB-00017559

therminol

HEATERS AND HEAT TRANSFER SYSTEMS...

. . . have been developed for a variety of uses. These systems have proved outstanding for chemical processing, petroleum refining, resin making, food cooking, platen heating, paint drying, oven drying, heating calendering rolls, and heating distillation vessels. A single THERMINOL heater may be used to provide processing heat for as many as ten or more use points.

Monsanto does not manufacture or design the heating equipment, but works closely with heater manufacturers and design engineering firms who are specialists in their field. Today, standard heaters are available in capacities ranging from small electrically-heated types to giant gas and oil fired units.

FIVE UNIQUE ADVANTAGES:

NO CONDENSATE RETURN PROBLEMS . . . The "user" processing vessels, ovens, kettles, calender rolls or platens can be installed at any elevation and at varying distances from heater.

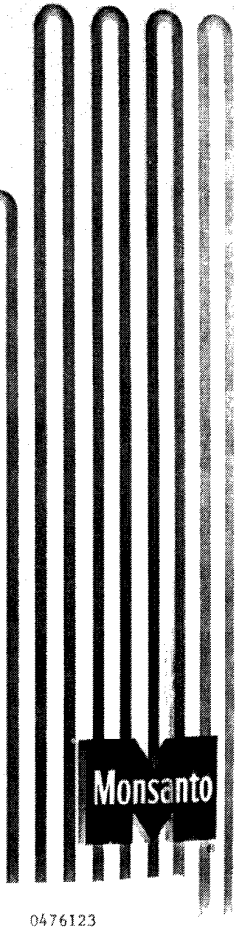
FASTER RESPONSE TO LOAD CHANGES . . . Multiple "users" operating at different temperature levels each maintain their temperature remarkably constant to within 2°F. despite load changes.

MINIMUM RADIATION LOSS . . . Therminol heating systems require smaller piping and smaller valves. Smaller diameter piping means less heat loss; the smaller control valves give more accurate control than large vapor valves.

PREDICTABLE HEAT TRANSFER . . . With Therminol liquid heat transfer, there is no unpredictable variation of heat transferred by sub-cooling of the condensate; heat delivered is virtually exact as calculated.

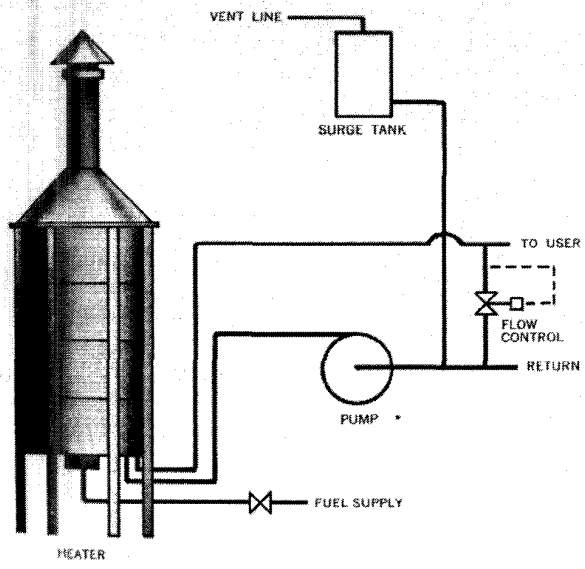
DUAL-PURPOSE: HEATING/COOLING . . . A Therminol system can serve to transfer heat in and out of processes that require cooling . . . by piping the liquid in a flow path where heating and cooling are done by this single medium.

SOUND DESIGN . . . Therminol cannot be indiscriminately used in heaters designed for oil, vaporizing organic liquids, or steam. However, often with minor changes a Therminol heater may be installed to operate with an existing distribution system.



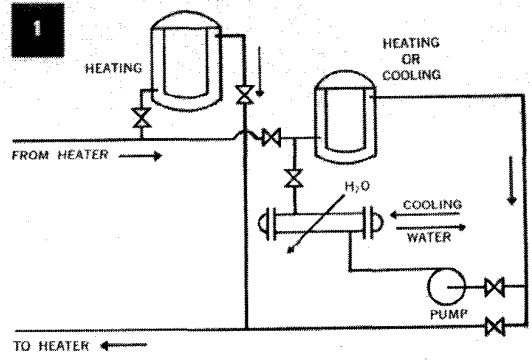
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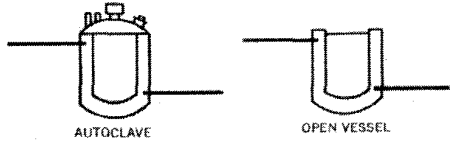
One heater can serve multiple "users" each at a different, selected temperature that is accurately held.

1



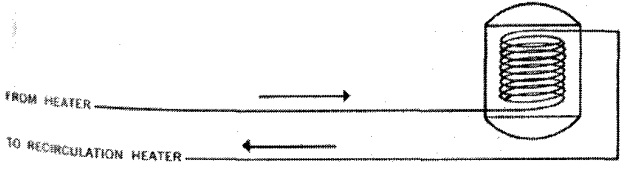
2

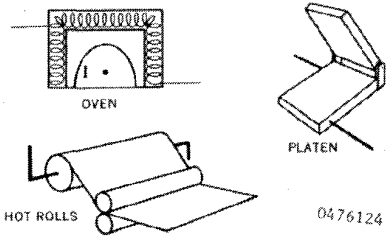
Single heaters can simplify serving a combination of users, such as autoclaves, open vessels, ovens, platens, hot rolls, since no pressurizing is required.



3

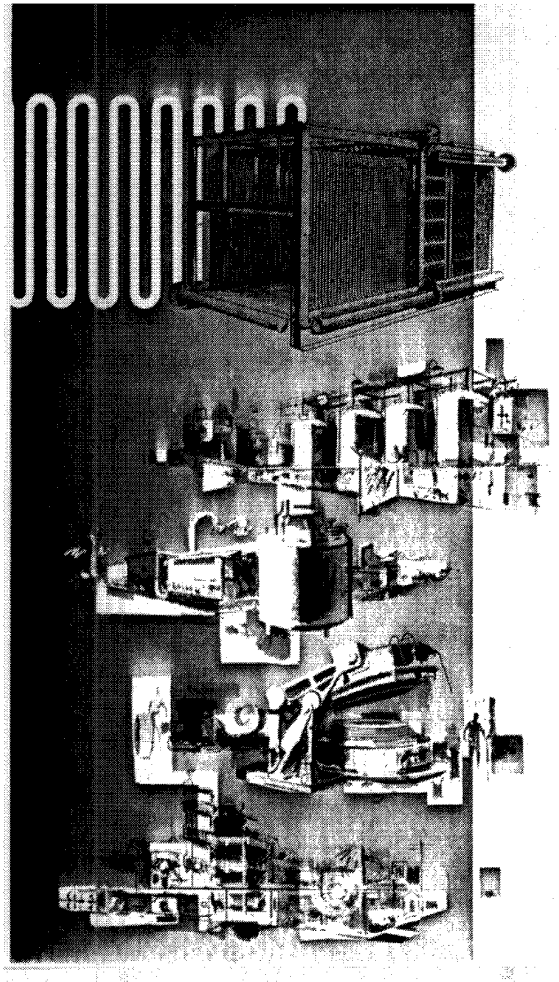
Heater can safely be used close to or far removed from "users" with minimum radiation loss.





0476124

TOWOLDMON0033092
WATER_PCB-00017561



YOU'LL FIND A

therminol

LIQUID HEAT TRANSFER SYSTEM BEST FOR THESE TYPICAL APPLICATIONS:

CHEMICAL PROCESSING . . .

- for safety from fires when handling, processing flammable materials.

VARNISH AND RESIN COOKING . . .

- for even, uniform heating of a series of kettles at different, closely-controlled temperatures—with one "circuit."

PLASTICS AND RUBBER MOLDING . . .

- for uniform heating, rapid heat-up, and pin-point temperature control.

HYDROCARBON AND BITUMINOUS MATERIALS HEATING . . .

- for maximum safety where explosive gases and volatile fumes evolve.

0476125

TOWOLDMON0033093
WATER_PCB-00017562

FOOD PROCESSING . . .

- for controlled, quality "cooking" of potato chips, pre-cooked frozen foods, soups and vegetables for canning.

MATERIALS CONVERSION . . .

- to heat corrugating rolls, crimping presses, calendars.

METALS TREATING OVENS . . .

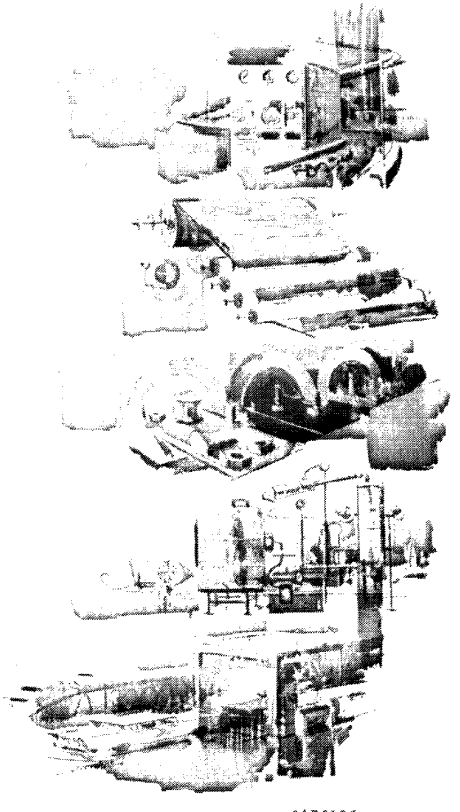
- for heat-treating metals such as titanium and vanadium; for "seasoning" weldments, castings and forgings.

MALT COOKING AND LIQUOR DISTILLATION . . .

- for efficient indirect heating of distillation equipment.

SURFACE HARDENINGS OF COATINGS . . .

- for automobiles, alkyd and melamine resins, finishing, and porcelainizing.



0476126

TOWOLDMON0033094
WATER_PCB-00017563

DISTRICT SALES OFFICES:

ATLANTA 9, GEORGIA
1401 Peachtree Street, N.E.
TRinity 6-0777

BOSTON 49, MASSACHUSETTS
Everett Station
DUnkirk 7-5010

CHICAGO 11, ILLINOIS
520 North Michigan Avenue
WHitehall 4-6760

CINCINNATI 6, OHIO
2330 Victory Parkway
PLaza 1-6710

CLEVELAND 22, OHIO
3645 Warrensville Center Road
991-5400

DETROIT 23, MICHIGAN
18250 Grand River Avenue
BRoadway 3-7090

HOUSTON 5, TEXAS
Texas Gas Building
2477 Bolsover Street
JAckson 6-2551

LOS ANGELES 22, CALIFORNIA
6670 East Flotilla St.
RAymond 3-2492

MINNEAPOLIS 2, MINNESOTA
Foshay Tower, Room 515
FEderal 9-4651

NEW YORK 22, NEW YORK
445 Park Avenue
PLaza 9-8200

PITTSBURGH 28, PENNSYLVANIA
20 Cedar Boulevard
LOcust 3-4010

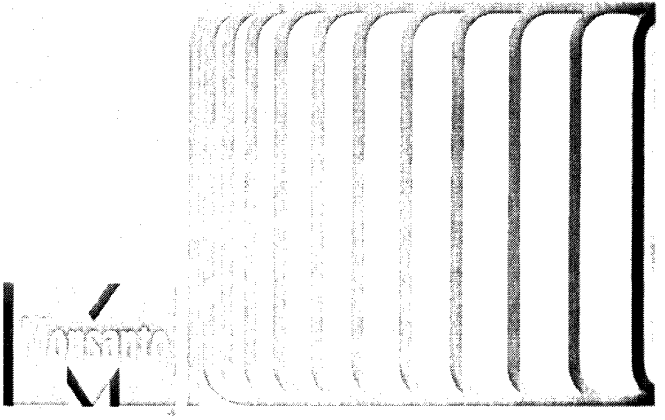
ST. LOUIS 66, MISSOURI
800 N. Lindbergh Boulevard
WYdown 3-1000

SAN FRANCISCO 4, CALIFORNIA
111 Sutter Street
YUkon 6-6232

SEATTLE 4, WASHINGTON
911 Western Avenue
MAin 2-4203

SYRACUSE 3, NEW YORK
731 James Street
GRanite 4-6801

WILMINGTON 3, DELAWARE
2005 Concord Pike, Fairfax
OLympia 8-6531



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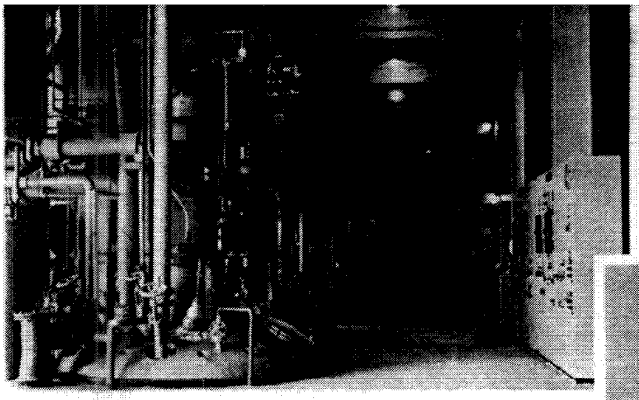


AND WE ARE . . .

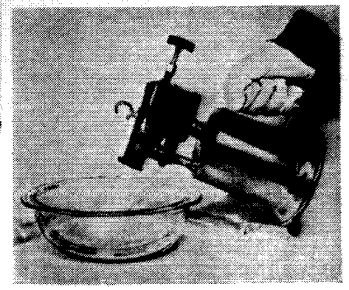
In this Therminol fluid heating systems summary booklet. Here, we have spelled out the benefits of liquid phase indirect heating — the safety, economy and low maintenance "built-in" to every Therminol fluid system. But we don't expect to convince you with our story, alone . . .

0476128

TOWOLDMON0033096
WATER_PCB-00017565



Fire-resistant chlorinated-biphenyl heat-transfer fluid provides safe, precisely controlled heat for the reaction of flammable resin materials in these 3,500 gallon kettles of a modern surface-coatings plant.



Simple "blow torch" test of new chlorinated-biphenyl heat-transfer fluid demonstrates its extreme fire resistance. To date it is the only heat-transfer fluid to obtain Underwriters' Laboratories, Inc. listing.

Fire-resistant Fluids Give New Safety to Heat Transfer

A new class of process heating has become available to industry following the recent Underwriters' Laboratories, Inc., listing of a family of heat-transfer fluids which operate at atmospheric pressures and which are far less a potential fire hazard than are the petroleum oils and synthetic fluids now commonly used in low-pressure heat-transfer systems.

Heat — at ever higher temperatures — is an increasingly important processing tool of industry. And in "putting on the heat," industry has turned to the economy, flexibility and precise temperature control obtainable through fluid heat transfer. It is not only common but also indispensable in the production of chemicals, food products, paints, petroleum, etc.

Water and steam are excellent and universal heat-transfer media, of course. But, above temperatures of 350°-450° F., in certain applications, the need for expensive high pressure equipment may rule out steam systems in favor of those using high-boiling fluids. These may be petroleum oils with relatively high flash points or, more often, thermally stable and noncorrosive synthetic fluids designed for the purpose. In some instances, these fluids vaporize at about 500° F. to simulate steam operation, but at much lower pressures for any given temperature.

Up until now, however, the use of petroleum oils or synthetic fluids for heat transfer has introduced the problem of potential fire hazard. These are combustible liquids which usually are circulated at temperatures at or above their fire points in closed systems. Should a break occur in such a system, personnel and equipment could be threatened by a flammable "wick" of vapor or fluid dangerously near its fire point. Consequently, all of the precautions associated with the circulation of a flammable fluid must apply to such systems.

A new class of chlorinated-biphenyl heat-transfer fluids which are thermally stable, noncorrosive and extremely fire resistant appears to offer a sorely needed method of high-temperature industrial heating with minimum hazards. The manufacturer of these fluids reports that they have undergone five years of testing by more than 200 industrial cooperators, during which time there has been no instance of a heat-transfer fluid fire implicating any of these chlorinated-biphenyl fluids.

Industrial field use of these fluids has included the heating of resin kettles, reaction vessels, metalworking press platens, cooking fats for deep frying, steam production in a non-fired heat exchanger and even the heating of hazardous jet engine fuels for high-temperature tests of engine performance.

In one reported instance of a chlorinated-biphenyl heat-transfer fluid installation in a paint manufacturing plant, a tube-bundle failure in the fluid heater caused the fluid to pour out into the fire box. Although there was a heavy fuming of the vaporizing fluid up the stack of the heater, there was no visible flame nor fire damage to the plant. With the repair of the tube bundle — and a fresh supply of fluid — the plant was back in production with a minimum of expense and work interruption.

Underwriters' Laboratories, Inc., has rated the new chlorinated-biphenyl heat-transfer fluids at 2-3 in respect to fire hazard, according to its Standard Classification of Liquids in which ratings are:

Ether	100
Gasoline	90-100
Alcohol (ethyl)	60-70
Kerosene	30-40
Paraffin oil	10-20

High-pressure-boiler codes are not fully applicable to systems employing the chlorinated-biphenyl fluids which are used in equipment operating at atmospheric pressure. In addition, since these fluids do not support combustion in their heat-transfer application, it appears that safety precautions now considered necessary for oil or synthetic-fluid heat-transfer systems may be modified for this class of fire-resistant fluids. Each installation must be considered individually, of course, because of other fire hazards which may be present in a given industrial plant.

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August, 1962 FIA Sentinel, Factory Insurance Association

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UNIVERSAL RESIN PLANT

Therminol ***heating system provides flexibility for producing range of resins, varnishes, bodied oils, and emulsions.***

by
I. E. RUBIN*

MANY producers of surface coating resins find a need for making a variety of resins in the same kettle. Usually this results from sales requirements for many different resins, in quantities too small to justify separate installations for each class. Among the resins generally produced are alkyds, polyesters, urea-formaldehydes, polyvinyl acetates and epoxys. There may also be requirements for some phenolic varnishes, bodying oils or even plasticizers.

Problems

In general, the production procedures for these resins are similar enough to warrant the possibility of processing all or many of them in one vessel. However, there are sufficient differences in raw material components and specific operating conditions for the various categories to lead to a variety of engineering problems which must be properly handled in designing the equipment. Some of these factors are illustrated by the following.

Physical Criteria

Table I indicates the range of temperature levels, heating and cooling rates and viscosities which may be encountered in the production of three types of these resins.

Cooking Methods

Alkyd resins require an initial high rate of heat-input, in order to reach cooking temperatures in a reasonable time. Once the batch is at operating temperature, the heat-input rate is drastically reduced, after which good temperature regulation is required. This is true whether fusion or solvent cooks are being conducted. At the end of the reaction, it is necessary to cool rapidly in order to stop the reaction at the desired condensation or polymerization point.

Urea-Formaldehyde resins are generally made by heating the mixed ingredients to about 140°F., adjusting pH to suit and then continuing the heating to about 180°F. Reaction is stopped by suitable pH adjustment after the required

Resin	Alkyd	PVA	U-F
Main Reactants	Fatty Acid Glycerol or PE Phthalic Anhydride	Monomer Dispersant Copolymers	Urea Formaldehyde
Typical Cooking Temperature	550°F.	190°F.	140°F.
Heat-Up Rate Desired	3-4°F./Min.	2-3°F./Min.	1-2°F./Min.
"Holding" Heat, as a fraction of maximum input during heat-up	10%	10%	20%
Cooling during reaction	None	Maximum	None
Cooling required at end of batch	Rapid	Some	Some
Viscosity at operating Temperature	3-10 cps.	100-200 cps.	50-150 cps.
Viscosity at room Temperature (80°F.)	5000 cps. to solid	1200 cps.	—

Table I. Temperature ranges, heating and cooling rates, and viscosities encountered in three types of resins.

*Industrial Process Engineers, Newark, N. J.

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condensation has been attained. Water is then removed, under vacuum, to obtain the desired solids content.

Polyvinyl acetate water emulsions are run by heating a small quantity of water, monomer and other ingredients to a given reaction temperature and then starting the gradual charging of additional monomer as the reaction proceeds. The reaction is quite exothermic and it is generally necessary to switch from heating to cooling. Cooling is more difficult than heating. (This can be predicted from the viscosity values given in Table 1. Since the cold resin in contact with the cooling surface acts as a viscous film and markedly increases the resistance to heat transfer, the reaction will not maintain itself if the cooling becomes excessive. It is then necessary to switch back to heating. Temperature control is therefore important and fairly difficult.

Heating Media

Steam, the most common heating medium in the chemical process industries, is not practical as a heat source over the entire range of temperatures involved in resin production. The 600°F. temperature involved in alkyd manufacture would require steam at over 1500 lb./sq. in pressure. Steam is used, of course, for the lower temperature work with PVA and Urea-Formaldehyde.

Dowtherm vapor is suitable only at the upper end of the operating temperature range, since "Dowtherm A" vaporizes at 500°F. at atmospheric pressure. Below this temperature, Dowtherm is generally used as a liquid heating medium and functions satisfactorily. However, with a liquid system of this type, if it is desired to retain the versatility for higher temperature operation, it becomes necessary to design for operation at 50 or 60 psig pressure. With this pressure in the jacket and the frequent need for an internal vacuum condition during many processing steps, it then becomes necessary to design the kettle for 65-75 lb/sq. in. external pressure. With standard jackets, this results in a thick, costly vessel shell.

Electric heating depends a great deal on the economics of the local

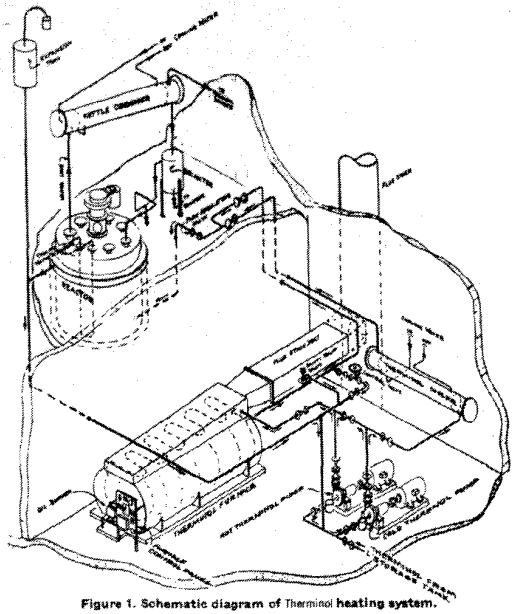


Figure 1. Schematic diagram of Therminol heating system.

cost of power. Radiant heat is generally used for the higher temperature range alkyd applications. Resistance heaters present the problem of possible local overheating and product discoloration where they are used directly in contact with the product or kettle wall. Electric heating also has the disadvantage of using most of the available outside kettle surface, thus reducing the total area available for cooling.

Direct-firing (gas or oil) is widely used in alkyd processing and lends itself very nicely to sophisticated systems of automatic control. This method is only suitable for higher temperature work.

Summary of the Problem

Thus, there are three main problems to be solved in designing for the flexibility of a "universal" resin plant:

1) Heat transfer and temperature control (Heating and cooling conditions).
2) Agitation and mixing requirements (Viscosity, reaction rate, etc.)
3) Ease of cleaning equipment for product change-overs.

The Solution

Solution Outline

The Process Plants Division of Industrial Process Engineers has evolved a unit which has the flexibility required for handling this wide variety of resins. This is accomplished by the following five basic adaptations:

a. Use of liquid Therminol FR-2 as the basic heat transfer medium for heating and cooling.
b. Provision of internal, water-cooled surfaces (baffles) in the vessel for additional cooling.
c. Provision of large diameter, variable-speed turbines which can handle a wide variety of batch viscosities.
d. Use of a polish finish for internal surfaces, to facilitate cleaning when changing from one resin to another.
e. Design of the vapor and condensing system to accommodate simple reflux

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ing, refluxing with vapor fractionation, decantation, etc.

Therminol Heating System

The Therminol system consists of an oil-fired Therminol heater (furnace), two circulating pumps, a Therminol cooler, an expansion tank, and the necessary piping and instruments. These are arranged as shown in Fig. 1.

Therminol is circulated continuously through the furnace, flowing to the kettle only as required. The flow of fluid during the heating cycle of the kettle follows the path: Discharge from the hot Therminol pump, through the furnace, through the kettle jacket and then return to the suction of the hot Therminol pump. The whole system is vented through an expansion tank which "rides" on the Therminol flow, thus allowing for expansion or contraction of the liquid. The line to this expansion tank is of small diameter (no more than 1"), and sufficiently long so that the fluid in the tank remains cold.

The furnace, its controls, and the Therminol pumps are located in a separate "non-hazardous" location, thus permitting the use of standard motors and instruments, without requiring explosion-proof features. The furnace is provided with all safety devices normally required by insurance carriers and local regulations. In addition, the system is designed specifically for Therminol in accordance with suggested by Monsanto Chemical Co.

The furnace controls include automatic temperature regulation based on Therminol outlet temperature from the furnace. The furnace "turns-down" to lower fuel (heat) inputs when the process so demands. In addition, the bulk temperature of the Therminol and the skin temperature in the furnace are measured and act as over-ride or safety signals if given values are exceeded. Finally, a positive means is provided for insuring adequate Therminol flow through the furnace at all times. Lack of adequate Therminol flow shuts down the furnace. During start-up periods, the furnace is held at low fire until the Therminol bulk temperature reaches 100°F., at which point the viscosity drops rapidly and proper pumping action can take place.

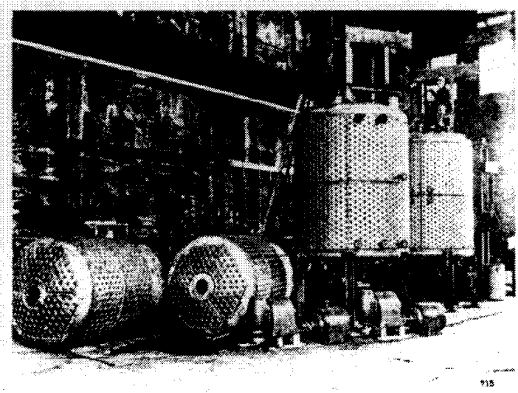


Figure 2. Dimpled jacketed reactors.

Therminol Cooling System

Two methods are available for cooling the contents of the kettle. "Cold" Therminol can be circulated in the vessel jacket or water may be circulated in special internal cooling baffles, described later. Both media may be used simultaneously, if necessary. The flow of Therminol coolant, as shown in Figure 1, is from the "cold" Therminol pump, through the Therminol cooler, then through the kettle jacket and returning to the "cold" pump. When using the "cold" Therminol pump, the expansion tank must still be connected to and "floating on" the system, as previously described.

The Therminol cooler is designed to take the thermal shock of the hot fluid which initially enters the unit. Since the exchanger itself is initially full of cold Therminol, there is very little effective time lag when switching from heating to cooling.

Therminol Pumps

The Therminol pumps are centrifugal units, suitable for high temperature service. Mechanical seals are recommended. The pump motors are sized to handle the high viscosity of the Therminol when cold.

For the sake of convenience, the "hot" and "cold" Therminol pumps are manifolded so that one acts as a spare for the other.

Kettle Jacket

The resin kettle is provided with a suitable jacket. Standard steel jackets and stainless steel dimpled jackets are used, the latter offering the advantage of maximum flexibility for future new uses or conversion of the vessel to other heating media. Figure 2 shows a photo of several dimpled jacketed reactors.

One great advantage in using Therminol is that the pressure in the jacket is always low, generally equal only to the static head of liquid in the expansion tank. The low jacket pressure reduces kettle cost by savings in wall thickness.

The jacket and the pumping system are designed to insure a minimum liquid velocity of 6 ft. per sec. in the jacket, for efficient heating or cooling.

Kettle Baffles (Water-Cooled)

For some processes, circulation of "cold" Therminol in the jacket produces adequate cooling; in other cases, this is totally inadequate.

In most heat transfer conditions, it will be found that the resistance of the Therminol film and the metal wall of the kettle are small in comparison to the resistance of the film of process fluid (resin or polymer) on the inside wall of the kettle. In some cases, this can be overcome by increasing the intensity of agitation (which is discussed below). In other cases, there is no possible solution but to increase the effective heat transfer surface. This is particularly true when cooling at low temperatures. Under these conditions, the Therminol

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film resistance also markedly increases.

Kettles are therefore provided with internal water-cooled baffles. These baffles are vertical, smooth and thus easily cleaned. Several types of baffles are used, depending on the anticipated use of the vessel. If a high proportion of PVA production is anticipated, the baffles are vertical triangular prisms, which offer a maximum of heat transfer area. Otherwise, simple "U" type pipe-bends are used. Four typical pipe baffles will increase the available heat transfer surface about 25%. However, since these baffles are more effective than the jacket in providing heat transfer, the net effect would be equivalent to an increase of almost 80% in the jacket area.

These baffles are suitable for steam heating as well as for water cooling.

The Kettle Agitator

In order to obtain good agitation for all resins, a variable speed drive is provided. However, in itself, rotational speed is not a sufficient criterion for good agitation. The size and type of impeller must be properly selected in relation to the kettle dimensions. The impeller diameter should be 40-55% of the vessel diameter. The range of speeds should be such that the peripheral speed of the impeller ("tip-speed") can be varied from at least 600 ft/min. to 900 ft./min. These units generally are designed to provide peripheral speeds of 400 to 1100 ft./min., with sufficient motor horsepower to cover the maximum speed. Skimping on horsepower is a false economy here, since much of the flexibility of the unit would be sacrificed.

With emulsion polymers, excessive shear forces at the tip of the impeller must be avoided or the emulsion may break and a poor product result. To reduce this problem, it has been found advantageous to use curved-blade impellers, similar to pump impellers. These require somewhat higher operating speeds to produce the same turn-over effect at the kettle wall as straight-bladed units of similar diameter.

In no case will adequate mixing or heat transfer be realized without adequate baffling. Baffles should be sized so that their projected width, at right angles to the direction of flow, is a minimum of 8-11% to the kettle diameter. They should be set sufficiently far from the wall of the vessel so that no dead pockets occur, and the area behind the baffles can be cleaned.

Kettle Temperature Control

Control of the kettle temperature, with the system described, may be either manual or automatic. When a variety of products are being made, most producers have relied on manual temperature control. Since the resin kettle requires almost constant attendance for batch observation, the expenditure for fully automatic control has not appeared economic. However, semi-automatic control, as, for example, controlling only heating, is relatively simple and inexpensive (generally less than $1000). On the other hand, provision of fully automatic temperature regulation, including switching from heating to cooling with Therminol and automatic use of the water cooled baffles, all as a function of batch temperature, could easily cost $6000. A programmed-type control is intermediate in cost, but requires that the resin producers be able to establish a reliable program sequence for each type of resin. Several standard programmed control systems have been developed which successfully cover the requirements of many producers.

Kettle Cleaning Features

Material of construction for the resin kettles under discussion is generally a #300 series stainless steel. Types 304L, 321 and 347 have proved adequate. The use of stainless 316 or 316L increases the kettle cost somewhat, but offers the advantage of greater process flexibility.

All internal welds are ground smooth. The interior surface of heads, shell and fittings is polished to at least a No. 2 finish (though a No. 4 finish is more desirable). The cost of surface finishing is approximately $2.50/sq. ft. for No. 2 and $3.25/sq. ft. for No. 4. Polished vessels should be subject to careful inspection before acceptance.

The kettle requires thorough cleaning when changing from one material to another. Where cleaning is to be accomplished by filling the vessel with liquids such as caustic or solvent, an air vent is provided at the uppermost point in the vessel, so that the vessel may be completely filled. If this is not done, large air pockets will remain and prevent the cleaning solution from reaching all parts of the vessel. The remaining "skin" will generally contaminate subsequent batches.

When the batch does not tend to leave a film on the inside of the top head, it is often possible to clean the walls and bottom head adequately using a spray technique. Filling the entire vessel with solvent for cleaning is quite costly, and may be avoided by providing a spray ring inside the knuckle of the upper head. This ring has small holes drilled around its entire periphery, so that the wash liquid runs down the vessel wall in a continuous sheet. The solvent can generally be pumped out of the bottom of the kettle and recycled. A 2000 gallon kettle can thus be cleaned with less than 200 gallons of solvent.

Kettles under 800 gallons capacity are frequently made with bolted flanged top covers, to permit opening the vessel for manual cleaning and maintenance. Most larger vessels are big enough to permit a workman entering via a manhole, thus eliminating the need for costly bolted flanges at the top head.

Other Design Features

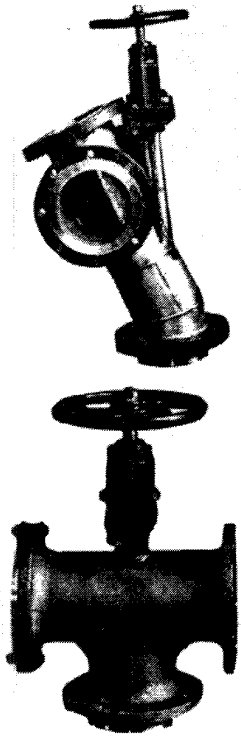
Other devices are often included to increase operating flexibility. For example, separate outlets are provided in the top head, so that both fusion-type and solvent-type alkyd cooks may be run. For this purpose, flush top valves are used to prevent pocketing. Two typical flush top valves are shown in Figures 3 and 4.

The condensing system is designed to provide adequate area for the most difficult service. Suitable decanters and receivers are provided so that single-phase or two-phase distillation may be carried out.

Since several resins require vacuum operation, the kettle, con-

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Figures 3 and 4. Typical flush top valves used in this system.

ITEM	DESCRIPTION
Kettle	66" O.D. x 72" straight side, #321 stainless steel; dimpled jacket; 4 water cooled baffles. Designed for full vacuum and 50 psig internal pressure. Provided with all suitable nozzles, and flush bottom outlet valve.
Condenser	350 Sq. Ft.
Decanter	100 Gallons, Stainless Steel
Receiver	500 Gallons, Carbon Steel
Therminol Furnace	Oil Fired (No. 2 Oil), rated at 1,500,000 Btu/hr.
Therminol Pumps (2)	300 GPM
Therminol Cooler	300 Sq. Ft.
Therminol Expansion Tank	200 Gallons
Piping	Include Therminol Piping, Vapor and Reflux Lines and Flush Valves.

Table II. Size of components for a 1000 gallon unit.

denser and other appurtenances should be designed for vacuum service. Once this criterion is met, it generally costs very little more to design the equipment for 40 or 50 psig internal pressure and this should be done. Operation under some pressure is indicated, for example, to decrease losses of glycols in polyester cooking.

The Cost

Systems as herein described have been operating successfully in a number of plants. They are particularly attractive where small volume production of several resins is economic. Table II indicates the typical size of components for a 1000 gallon (working capacity) unit. The components as listed would cost approximately $45,000.

A "package plant" cost, including building, utility piping and process piping, cooling tower, filter press, inert gas generator end complete installation would be in the range of $150,000 to $175,000.

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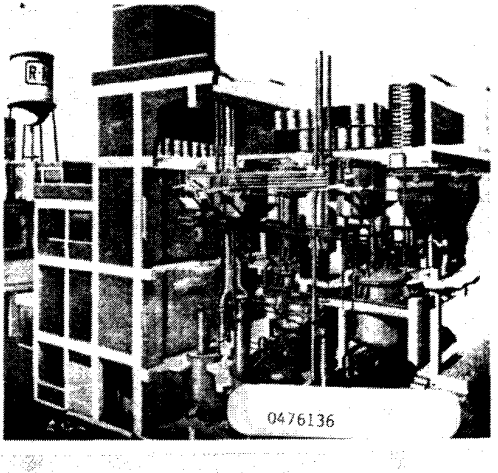
PRODUCTION

PACKAGING

MATERIAL HANDLING

NEW EQUIPMENT and MATERIALS

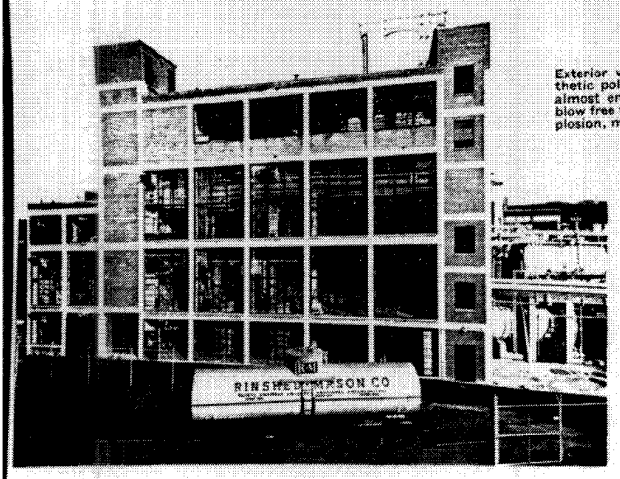
Artist's drawing of Rinshed-Mason's 1½ million dollar resin plant showing gravity flow design which helps reduce material handling costs.



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Exterior view of Rinshed-Mason Company's synthetic polymer plant. The facing wall is composed almost entirely of "clip-in" windows which would blow free with little resistance in the event of an explosion, minimizing total, overall damage.

RESIN PRODUCTION AT RINSHED MASON

By Howard H. Robinson, Jr.* and Edwin R. Wolfe**

ACCURATE, fully-controlled kettle temperatures, exact component measurement, high production efficiency, improved quality and a great increase in safety—these are among the benefits achieved by Rinshed-Mason Company, Detroit, in building a new centrally-heated, closed, solvent-cooking system for resin production. These resins are used by Rinshed-Mason Company in the production of a multitude of industrial paints and chemical coatings.

The fully modulated heating system for the kettles was designed around a liquid heat-transfer medium that operates at atmospheric pressure to produce minimum color and high quality synthetic polymers.

Safety Features

The system and the building constructed especially to handle the processing equipment offer the utmost in safety. The synthetic fire-resistant heat transfer fluid is heated in a separate building and pumped to the polymer plant through insulated pipes. The comparatively low heat range at which the reactors operate—generally between 125°F and 550°F.—reduces the danger of auto-ignition of any of the chemicals and oils involved.

Capacity of the four-story plant, opened in 1958, is more than three million pounds of resin a month, including alkyds, acrylics, water-soluble resins, polyesters, epoxies and other paint and chemical coating resins. It is located on the eight-acre Detroit site, which houses the largest of the Rinshed-Mason manufacturing operations, general offices, and extensive laboratory research facilities. There are also plants in Anaheim, Calif., Windsor, Ontario, Canada, and the former Wolverine Finishes Corporation plants in Grand Rapids, Mich., and Morganton, N. C.

Rinshed-Mason is a major supplier of automotive finishes for original car production, automotive refinishing products, and industrial finishes, including mobile homes, appliances, boats and motors, aircraft and missiles, etc., and through the Wolverine plants—furniture finishes.

In the face of rapidly expanding industrial sales and a correspondingly greater demand for more and better resin, the entirely new, $1\frac{1}{2}$ million plant was constructed in 1958. The fire-resistant, reinforced concrete structure is located at the edge of the manufacturing area. The wall facing away from the other facilities is made almost entirely of glass "clip-in" windows. These are designed to yield under pressure to prevent an explosion occurring which could render the sprinkler system useless. The other three sides are windowless firewalls.

Gravity Flow System

The four-story design provides for a gravity-flow system to reduce material-handling costs.

Top Floor—Dry raw material storage.

3rd Floor—Weighing and metering equipment the tops of three process kettles and the master control panels.

2nd Floor—Automatic control valves, Therminol pumping equipment, and tops of thin-down tanks.

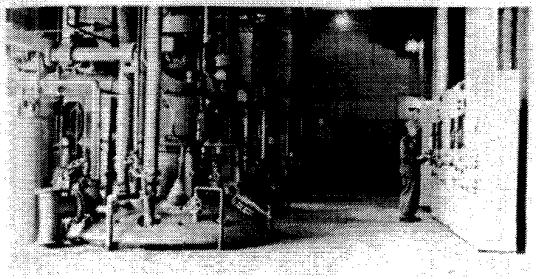
1st Floor—Thin-down tanks and filtration equipment.

In-process resins are held in eleven insulated, 7000-gallon tanks

*Factory Manager, **Engineer, Polymer Plant, Rinshed Mason Co., Detroit, Mich.

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Tops of three reaction kettles and their master control panels are located on the third floor. Chief kettle operator Jack Greenway records temperature and pressure readings from one of the panels, onto his control log.

located on a heated slab adjacent to the polymer building. Also, adjacent to the building are storage tanks for solvents, oils and chemicals, with a total capacity of up to 1½ million pounds.

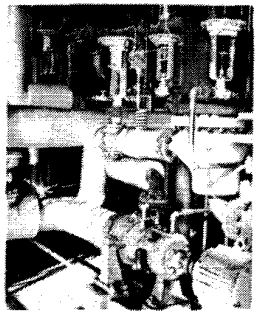
A six-million BTU/hr. gas-fired heater for the system is located in a separate building. A main circulating pump supplies the heat transfer fluid, Therminol FR-2* through insulated pipes to the polymer plant.

Each kettle also has its own circulating pump and a series of pneumatically-controlled valves, including a three-way modulating valve, which controls the flow of Therminol into the three zoned jacket surrounding the kettle. Thus, with one heating unit each kettle is operated independently and at different temperatures.

The independent circulating systems in the kettles allow complete modulation of both heating and cooling cycles. The efficiency of the heat-transfer medium, and the ease with which it can be controlled permit complete temperature flexibility in each kettle.

Two of the three resin production systems consist of 3500-gallon agitated reaction kettles, 500-square-foot condensers, and 7000-gallon thinning tanks. The third system has a 1000-gallon kettle, a 400-square foot condenser and a 2000-gallon thinning tank. All three have automatically-controlled, continuous water decanting solvent refluxing equipment.

*Trademark of Monsanto Chemical Company.



This closeup of a kettle's recirculating pump and part of the valve complex shows the insulated pipes which are the "hot" side of the system, and (upper right) the beginning of the water-jacketing which enables complete modulation of the "cold" side.

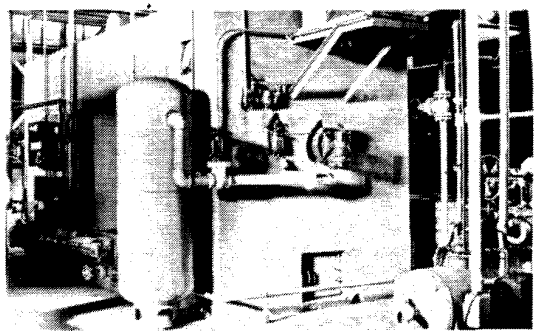
There is room in the polymer plant for two more 500-gallon kettles and related equipment. There also is room in the heater building for another six-million BTU/hr. Therminol heater.

Automatic Controls

On the fourth floor of the polymer building dry materials enter the system through a hopper scale which moves on dual tracks to the kettles. Liquids are pumped into weight tanks from outside storage. The liquid weighing system is controlled electronically with automatic record printing and item sequencing. As materials are weighed, an electric typewriter automatically records the batch number, date, item, and exact weight. The typewriter, not being explosion-proof, is located in the motor control center, a small "outside" room adjacent to the third floor.

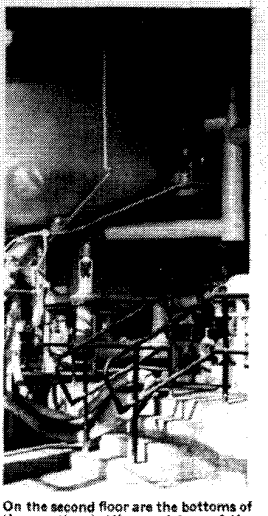
All kettle controls are located on identical third floor panel boards near the tops of the reaction kettles. In addition, a multi-point temperature recorder in the superintendent's office marks a permanent record of 16 operating control points. During processing, batches can be heated and/or cooled independently within the operating range of the Therminol -up to 600°F.

When a resin reaction is completed, the resin flows from the kettle down into the thinning tanks containing the required let down solvent. The resin is then filtered and pumped into the storage tanks mentioned earlier, until it is used in



The heat transfer liquid, Monsanto Chemical Company's Therminol FR-2, is heated in this six-million BTU unit located in a nearby building. Natural gas is the primary fuel, with stand-by oil service also available.

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On the second floor are the bottoms of the reaction kettles, and tops of the thinning tanks. Each kettle has its own Therminol circulating pump (right), and system of pneumatically operated valves (upper right). Thus, the one central heating system can operate each kettle at a different temperature.

producing a complete Rinshed-Mason finish.

By using Therminol, a non-pressurized, non-flammable system was made possible. This reduced the installation and maintenance costs and made a safer operation.

A good illustration of the safety attained with this heat transfer media occurred during the start-up of the polymer building when a tube-bundle failure in the central heater resulted in Therminol pouring into the fire-box. Smoke and fumes resulted, which went up the stack. However, there was no fire, and the plant was back on stream in two weeks. With a volatile heat-transfer media, a serious fire might have resulted.

In addition to the production systems, there are two complete pilot kettle plant systems. The 100-gallon kettle duplicates as closely as possible the larger units, even to a similar control panel and Therminol circulating system. The second unit is a five-gallon kettle and is the first step beyond the "test tube" stage.

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. . . So read what **others** have to say about low-pressure, liquid phase heat transfer! Many articles and "success stories" have been written about Therminol fluid heating systems — this pocket contains just a few of them for your review. In addition, Therminol has been widely accepted by industrial insurance companies, is listed with Underwriter's Laboratories. This wide product acceptance lends much strength to our . . .

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THERMINOL®

FIRE RESISTANT FLUIDS

TAKE THE PRESSURE OUT OF PROCESS HEATING

Let Monsanto help you engineer a nonpressurized, all liquid, nonvapor heating system that'll deliver stable, steady, safe heat at temperatures up to 600° F.



Working with THERMINOL, design engineers can give you heat transfer systems of unmatched flexibility, efficiency and economy. Here's why:

Monsanto Therminol fluids are specialized engineering materials, chemically "tailored" for heat transfer use. You know exactly how they are going to behave because they are manufactured to precise specifications of thermal stability, conductivity, specific heat, nonvolatility, and viscosity. They are the only liquid heat transfer fluids that are so manufactured! The only ones with these guaranteed specifications — and hence, such dependable performance.

The fire resistance of the Therminol fluids is recognized by both the Factory Insurance Association and the National Fire Protection Association. They are the only heat transfer media listed by Underwriters' Laboratories, Inc.

Take the pressure — the fire danger — the "surge and ebb" heat delivery *out* of your process heating. Write for a copy of THERMINOL FLUID HEATING SYSTEMS. It will tell you how.

MONSANTO CHEMICAL COMPANY
ORGANIC CHEMICALS DIVISION
Dept. 266 St. Louis 66, Mo.

Monsanto

Gentlemen: Please send me literature on Therminol Fluid Heating Systems.

*Name*_____ *Title*_____

*Company*_____

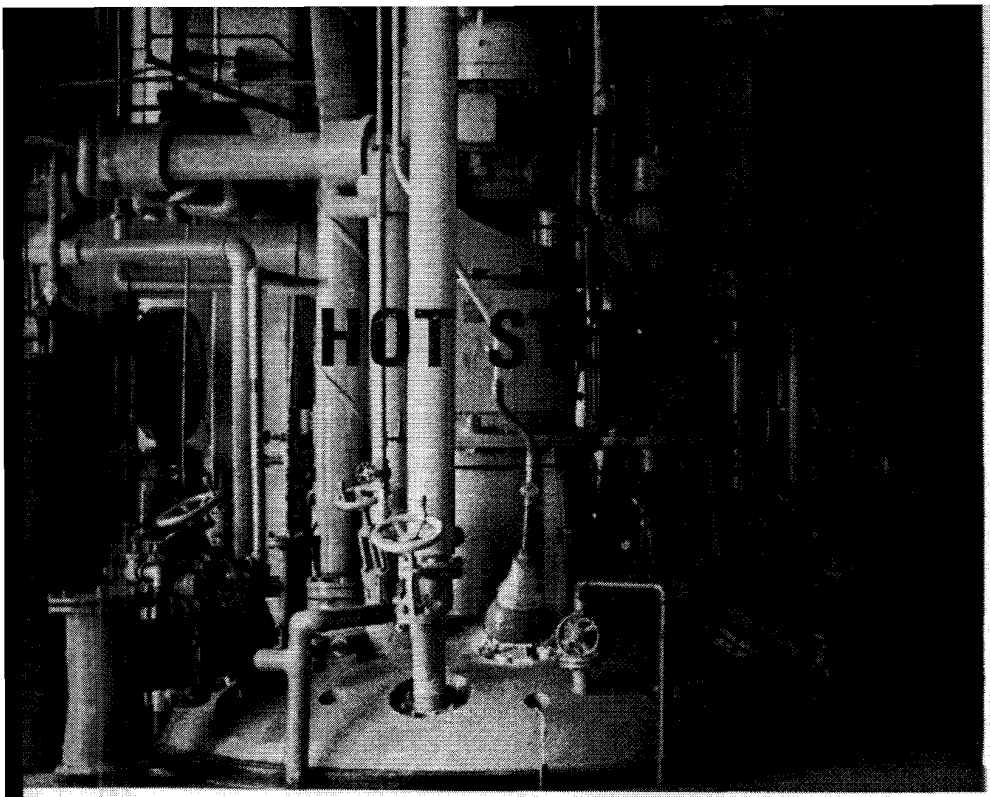
*Address*_____

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*City*_____

Zone *State*

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but no sweat!

Fire-resistant THERMINOL® FR delivers safe, controlled heat to 600° F. in low-cost, nonpressurized liquid systems.

The Therminol heat transfer system in this surface coatings plant provides safe, precisely controlled heat for the reaction of flammable resin materials in these 3,500 gallon kettles. Here's why:

Monsanto Therminol fluids are specialized engineering materials, chemically "tailored" for heat transfer use. You know exactly how they are going to behave because they are manufactured to precise specifications of thermal stability, conductivity, specific heat, nonvolatility, and viscosity. They are the only liquid heat transfer fluids that are so manufactured! The only ones with these guaranteed specifications—and hence, such dependable performance.

The fire resistance of the Therminol fluids is recognized by both the Factory Insurance Association and the National Fire Protection Association. They are the only heat transfer media listed by Underwriters' Laboratories, Inc.

Take the pressure—the fire danger—the "surge and ebb" heat delivery *out* of your process heating. Write for a copy of THERMINOL FLUID HEATING SYSTEMS. It will tell you how.

Monsanto®

Monsanto Chemical Company
Organic Chemicals Division
Dept. 68
St. Louis 66, Mo.

Gentlemen: Please send me literature on Therminol Fluid Heating Systems.

Name _____ Title _____

Company _____

Address _____ 0476142

City _____ Zone _____ State _____

TOWOLDMON0033110
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ADVERTISING PROGRAM!

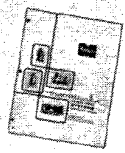
You may have seen these ads in Chemical Engineering, Chemical Processing or Chemical and Engineering news. They are designed to condense a big product story down to three essential "ingredients": Safety—Economy—and Reliability. If you are considering an indirect heating system — and one or all of these "ingredients" appeal to you . . .

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WATER_PCB-00017580

ASK FOR MORE INFORMATION ABOUNT LOW-PRESSURE, LIQUID PHASE INDIRECT HEATING WITH THERMINOL, TODAY! TAKE YOUR CHOICE . . .

* SEND FOR MONSANTO'S COMPLETE, 47-PAGE THERMINOL ENGINEERING DATA BOOK



* SPECIFY THERMINOL ENGINEERING DESIGN ARTICLE REPRINTS ON THE RETURN CARD

* SEND FOR A LISTING OF HEAT TRANSFER EQUIPMENT AND SYSTEMS DESIGN COMPANIES

* CHECK THE CARD FOR A SAMPLE OF THERMINOL FR HEAT TRANSFER FLUID

* ASK FOR COMPLETE PRICING INFORMATION ON THERMINOL FLUIDS.

* HAVE A MONSANTO FLUIDS SPECIALIST CONTACT YOU TO ARRANGE AN APPOINTMENT

* CHECK OFF "APPLICATION DATA FORM" IF YOU ARE INTERESTED IN CONVERSION

OR

* CALL STAN SHAW, MONSANTO'S THERMINOL TECHNICAL SPECIALIST AT WYdown 3-1000, ST. LOUIS, MISSOURI (Area Code 314). CALL STAN COLLECT, AT MONSANTO — HE WILL BE GLAD TO DISCUSS YOUR SPECIFIC HEAT TRANSFER SYSTEM NEEDS WITH YOU . . . NO OBLIGATION!



YES . . . I'd like more information on THERMINOL liquid phase indirect heating: please . . .

- ☐ Send the THERMINOL Engineering Data Book
- ☐ Send Article Reprints on Engineering Design
- ☐ Send the Equipment & Systems Design Co. List
- ☐ Send a Sample of THERMINOL FR-2
- ☐ Send complete pricing information
- ☐ Have a Fluids Specialist contact me
- ☐ Send the Application Data Form
- ☐ Never mind—I'll call Stan Shaw

Name..... Title.....

Firm..... Address.....

City, Zone, State.....

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