Dr. K. Srinivas Reddy
Professor

#204, Heat Transfer &Thermal Power Laboratory
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Indian Institute of Technology Madras
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Form for Inviting Quotations

Reference No.: MEE/16-17/345/DSTX/KSRS/16-I **Date:** 31-10-2016

Subject: Supply and set up of Thermocline thermal energy storage system
Project No: MEE/16-17/345/DSTX/KSRS

Due Date: 21 -11-2016

Dear Sir,

1. Quotations are invited in **duplicate** for the **supply and Setup for Thermocline thermal energy storage system** and Specification of which are shown in overleaf.

2. The Quotations **duly sealed and super scribed on the envelope** with the reference No. and due date, should be addressed to the undersigned to reach him on or before the due date stipulated above.

3. The Quotations should be valid for sixty days from the due date and the period of delivery required should also be clearly indicated.

4. If the item is under DGS&D Rate Contract, Rate Contract Number and the price must be mentioned. It may also please be indicated whether the supply can be made direct to us at the Rate Contract price. If so, please send copy of the R. C. (Please note that we are not Direct Demanding Officers).

5. Relevant literature pertaining to the items quoted with full specifications (and drawing, if any) should be sent along with the Quotations, wherever applicable. Samples if called for should be submitted free of charges, and collected back at the supplier's expenses.

6. **Local Firms**: Quotations should be free delivery to this Institute, if Quotations are for Ex-Godown delivery charges should be indicated separately.

7. **Firms outside Madras**: Quotations should be F.O.B. Madras. If F.O.B. consignor station, freight charges by passenger train / lorry transport must be indicated. If Ex-Godown, packing, forwarding and freight charges must be indicated. The following set of documents is required in all cases: a. complete set of Clean Bill of Lading / Airway Bill / Air or surface Parcel Receipt, showing that the goods have been shipped and freight prepaid. b. Insurance Policies / Certificates in duplicate covering Marine Insurance as per Institute Cargo Clauses (All risks) and perils as per Institute Strikes, Riots and Civil Commotion Clauses, War risks as per Institute, Clauses. Cover for CIF value plus 10 percent.

8. The rate of Sales / General Taxes and the percentage of such other taxes legally leviable and intended to be claimed should be distinctly shown along with the price quoted. Where this is not done, no claim for Sales / General Taxes will be admitted at any stage and on any ground whatsoever. **The taxes leviable should take into consideration that we are entitled to have Concessional Sales Tax applicable to non-**
Government Educational Institutions run with no profit motive for which a concessional. Sales

Tax Certificate will be issued at the time of final settlement of the bill.

9. Goods should be supplied carriage paid and insured.

10. Goods shall not be supplied without an official supply order.

11. **Payment**: Every attempt will be made to make payment within 30 days from the date of receipt of bill / acceptance of goods, whichever is later.

Quotation can be sent addressing:

"Dr.K.Srinivas Reddy
Professor
#204, Heat Transfer and Thermal Power Laboratory
Department of Mechanical Engineering
Indian Institute of Technology, Madras- 600 036"

TEST SETUP FOR THERMAL THERMOCLINE THERMAL ENERGY STORAGE SYSTEM

S.No	Component	Specification	No.	Purpose
1	Oil Tank with stand (cylindrical)	Capacity - 100 ltrs Material – S.S 316, Thickness 3mm Diameter 40cm, Height 80cm	1	To have reserve of heat transfer fluid
2	Thermocline tank with stand (Cylindrical)	Capacity – 50 ltrs Material – S.S 316, Thickness 4mm Diameter 25cm, Height 100cm	1	To storage thermal energy
3	Electric Heater tank with stand	Heater wattage 5 kW (2 No.) Tank size 30 ltrs, Material -S.S 316, thickness 4mm, Diameter 30 cm, Height 45 cm	1	To heat the oil
4	Water Tank	Capacity – 50 Ltrs Material – Sintex Plastic tank	1	To circulate water in heat exchanger circuit
5	Shell and Tube Heat Exchanger	Hot fluid -Thermonol Vp-1, Cold fluid -Water Hot inlet 280^{o}C, Hot Outlet 80^{o}C, Cold inlet 30^{o}C, Cold Outlet 70^{o}C,	1	To cool the oil before entering in oil reserviour
6	Thermostat	Cut off temperature 400^{o}C	2	To switch off the heater automatically
7	RTD and Thermowell	Range upto 500^{o}C, RTD length: 6 cm Thermowell: Screw type welded in tank	15 set	To measure temperature at different level in thermocline tank, input and output of electric heater
8	Pressure Transmitter	upto 10 bar	2	To measure fluid pressure at input and output of thermocline tank
9	Gear Pumps	0.5 HP	1	To pump the oil in the circuit
10	Water Pump	0.5 HP	1	To pump water in cooling circuit
11	Oil filter	0.5 mm mesh filter	1	To protect the gear pump from blocking
12	Flow meter	Digital, range 0.1-20 LPM	1	To measure flow of oil in the circuit
13	Valves	Needle Valve SS, 10 no. Size 1 inch	12	To divert heat transfer fluid and control the flow
14	Valves	Non return valve SS, Size 1 inch	4	To control the flow of fluid
15	Pipes and pipe bends	SS 316 30m, size 1 inch PVC 10m, size 1 inch	-	To connect various component of the circuit
16	Insulation	Rockwool material	-	To prevent the heat loss
17	Gasket	Sustain temperature upto 400^{o}C	20	
18	Flanges	10 mm thickness SS Type	15	
19	Skid with wheel	Required compact dimension	1	To place complete set up over the skid

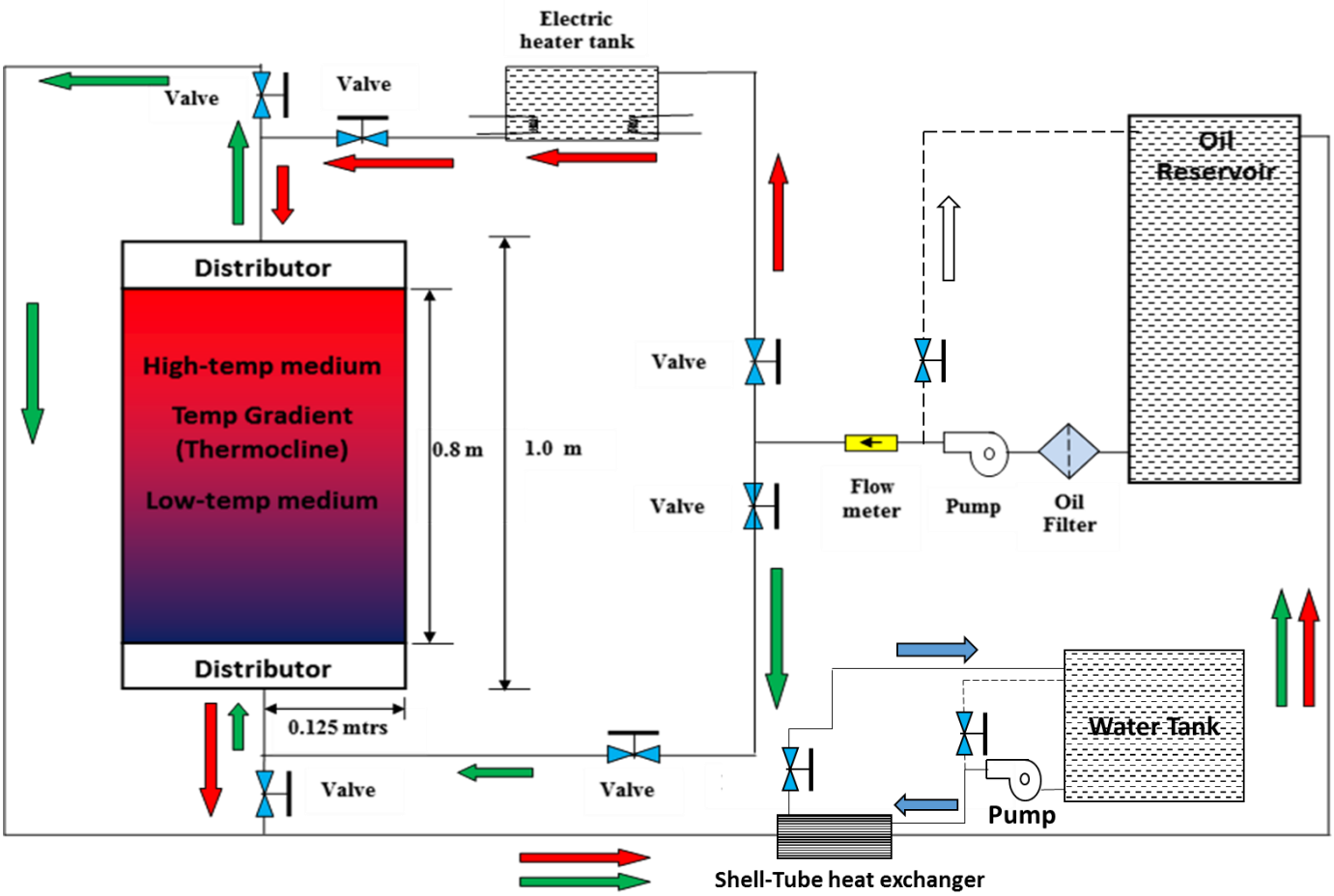

Figure: Schematic of thermocline thermal energy storage system

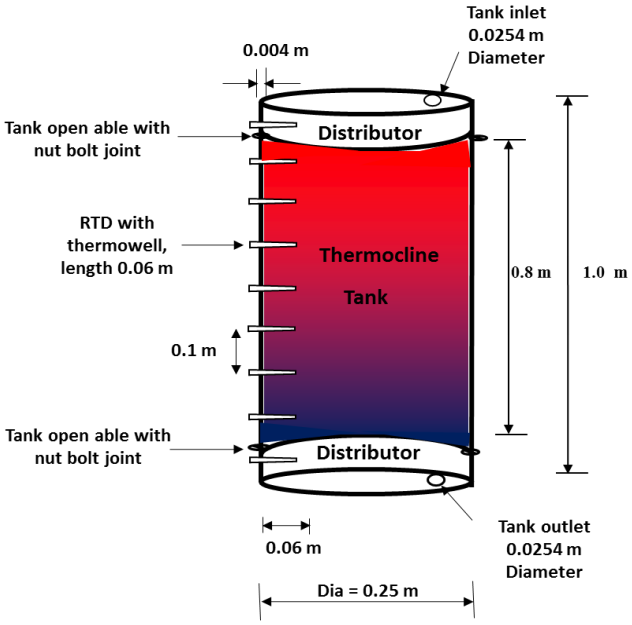

Figure: Front view of Thermocline tank

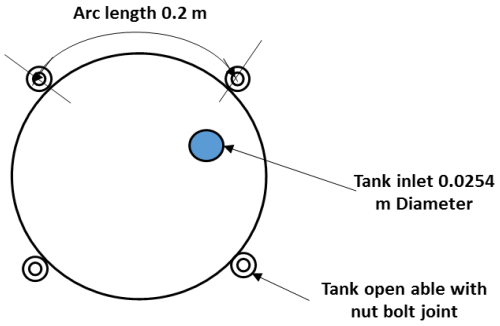

Figure: Top view of Thermocline tank

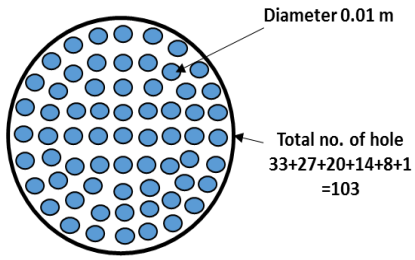

Figure: Top view of Distributor of Thermocline tank

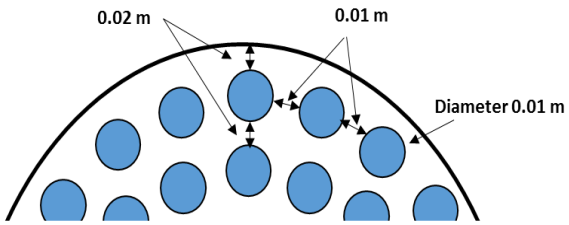

Figure: Top view of distributor of Thermocline tank

Further specifications

1. **Shell and Tube heat exchanger**

Thermal Specification

Shell side -Temperature of the hot fluid (inlet)	=	280^{o}C
Shell side -Temperature of the hot fluid (outlet)	=	80^{o}C
Tube side -Temperature of the cold fluid (inlet)	=	30^{o}C
Tube side -Temperature of the cold fluid (outlet)	=	70^{o}C
Hot oil flow rate	=	0.028 kg/s
Cooling water flow rate	=	0.132 kg/s
Heat Load	=	11 kW

Thermal Design

Baffle spacing	=	0.05m
Tube size	=	ID 16mm, OD 20mm
Number of tubes, N_t	=	5
Shell inside diameter	=	93mm
Length	=	1m
Tube pitch	=	Triangular pitch 25mm

Materials

Casing	=	SS304
Base plate	=	Mild Steel
Water chamber	=	SS304
Upper cap	=	SS304
Seal plate	=	SS304
Tube	=	Copper

2. **Thermocline Tank:**

a) It is open able with nut bolt joint from both end at length of 0.1m from each end.

b) RTD of 6cm length are installed with Screw type thermowell welded at every 0.1m.

c) Tank inlet and outlet pipe diameter is 0.0254m at top and bottom of the tank.

d) Distributor at 0.1m length form both end of the tank have total no. of 103 hole as specified in the diagram.

3. **Electric Heater tank**
   a) Two electric heater of 5 kW each are installed in the bottom layer of the tank.
   b) Two RTD are installed with screw type thermowell welded at inlet and outlet of the tank.