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(61)

The authors have proposed a modified solar water heater, supplemented by electrical heating arrangements. The system is automated in such a way that maximum amount of solar energy is utilised thus conserving the electrical energy by 30-100% depending upon the inlet water temperatures.

Systems Design for Supplementary Water Heating by Solar Energy

A system design has been proposed for supplementary water heating by solar energy for large installations in hotels, hospitals, etc., where the water is heated electrically. The water is pre-heated by solar energy and the additional heat is provided by electricity thus a saving in electrical energy is achieved. It is calculated that at different water temperatures the electrical energy saving ranges from 20% to 100%. Care has been taken to prevent the loss of energy by radiations from solar collectors when the solar radiations are not available.

Introduction

Keeping in view the energy crisis it will be beneficial to use solar energy for water heating systems. The reservation of the system is the weather, when the sunshine is not available. The proposed system deals with the hot water installations where the water is heated by electrical energy in geysers. Solar energy will be used for pre-heating of the water, i.e. the pre-heated water will be used as the inlet supply to the geyser. An automatic control will be used to prevent the radiation losses from the collectors when the sunshine is not available as well as to use the hot water when it is directly available to reduce the electrical consumption to the minimum.

System Design and Layout

The system proposed is a conventional solar water heating system with the modification as shown in the flow diagram (Fig. 1). The hot water from the collectors is circulated to the tank through the main feeder pipe to the geysers and stored in the storage tank. The details are shown in Fig.2. If required during the day time, the hot water from the collectors, which is flowing through the main feeder pipe, is taken to geysers and a nominal amount of electrical energy would be required to raise the temperature to the desired level of 65°C.

A differential temperature controller is used to sense the temperature difference between the water in the solar collectors and the storage tank. The temperature controller is designed in such a way that when the collector temperature is higher than that of the storage tank, solenoid valve (1) is open

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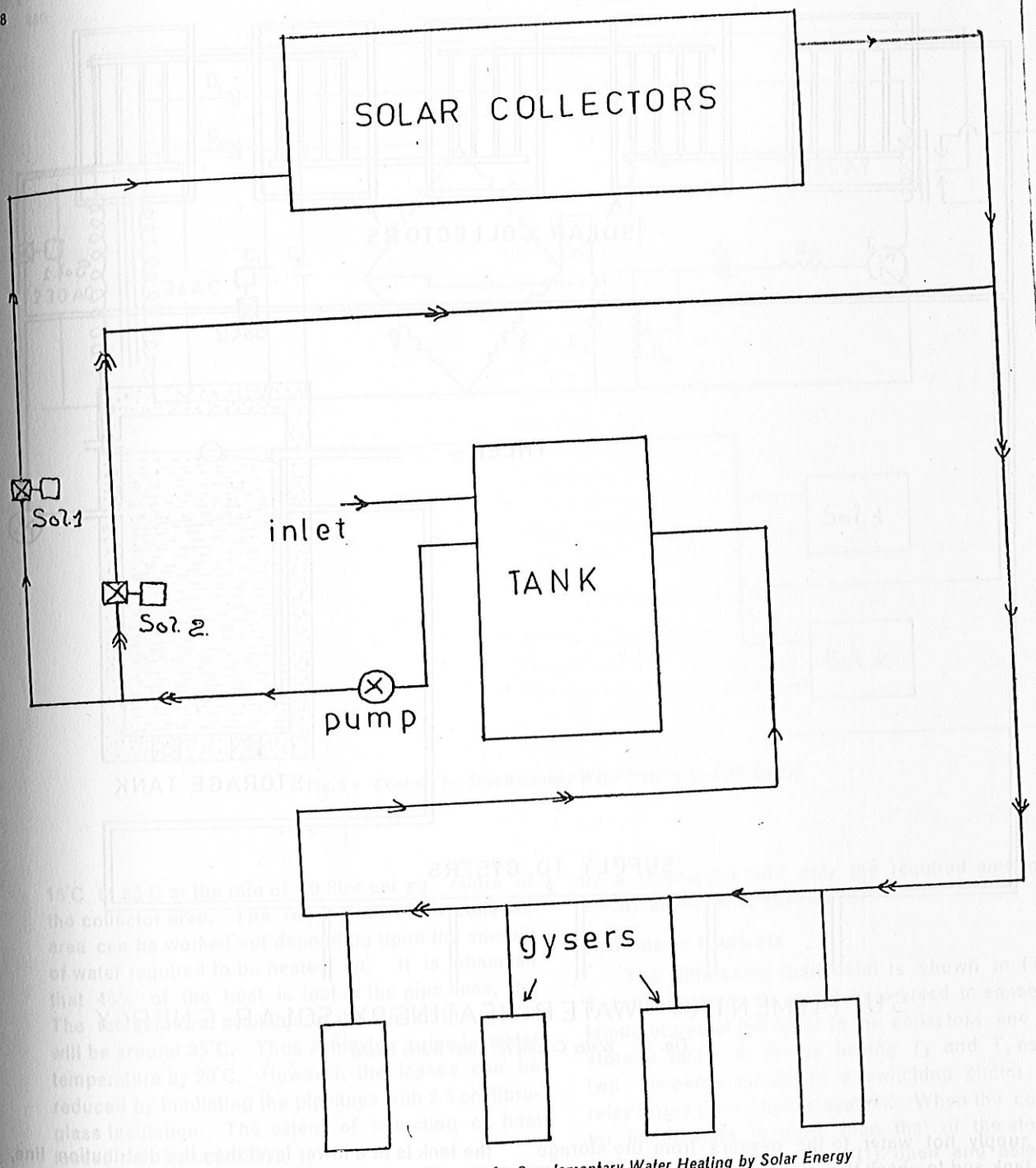

Fig. 1 : *Block and Flow Diagram for Supplementary Water Heating by Solar Energy*

and solenoid valve (2) is closed, the hot water from the collectors will be circulated to the storage tank through the main feeder pipe to the geysers. When the sunshine is not available and the collecto temperature falls below the stored water temperature solenoid (2) opens and solenoid (1) closes so as t

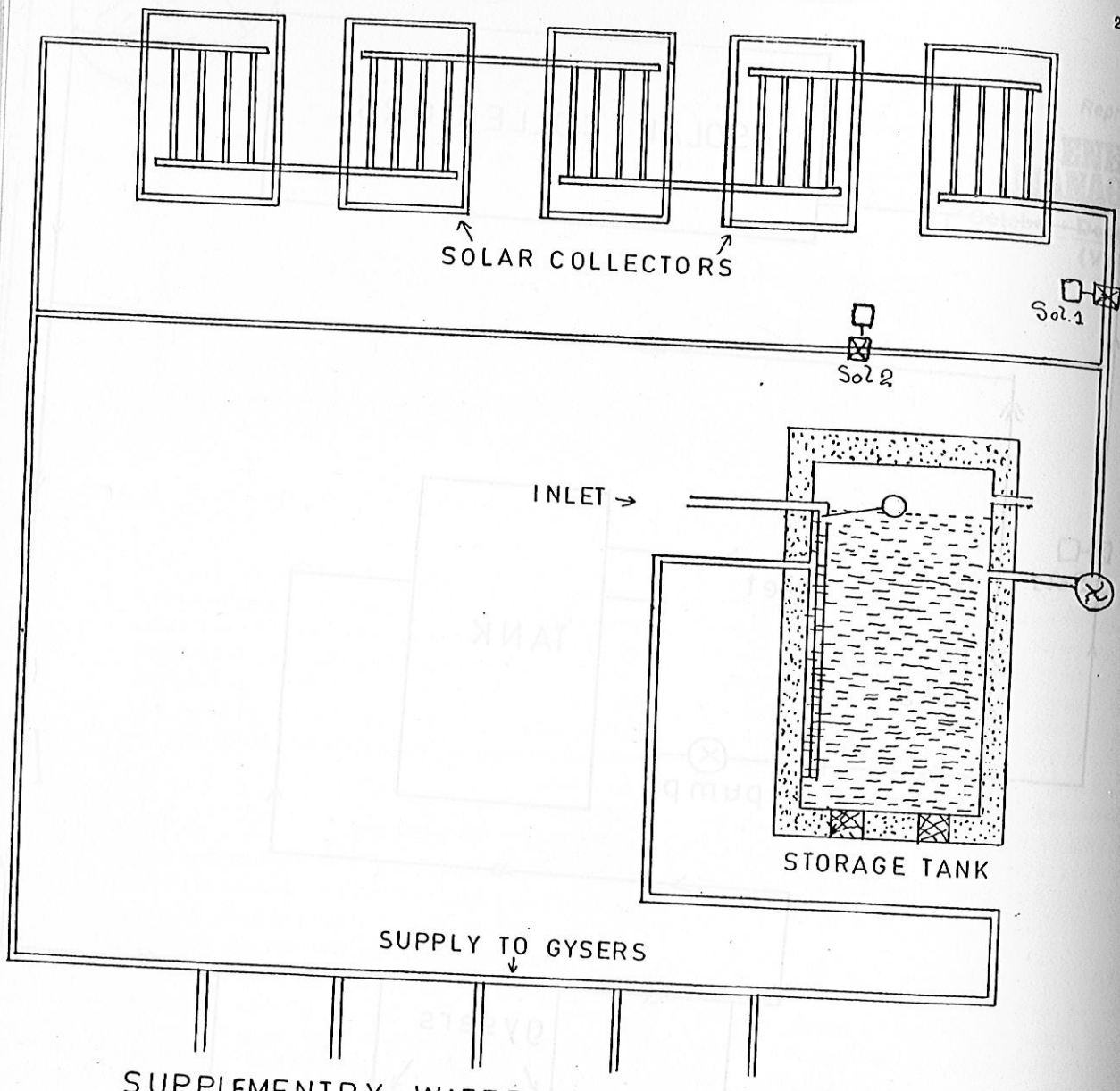

Fig. 2 : *Water Circuit for Solar Water Heater*

supply hot water to the geysers from the storage tank and to check the circulation of water through the collectors to prevent the radiation losses from the collectors. If the water storage tank is at a higher level, pump can be made to operate only when the sunshine is available and the water will flow in the distribution line by gravity only, but if the tank is at a lower level than the distribution line, the same pump can operate for the distribution purposes also.

Solar Water Heating System

The complete installation is shown in Fig. 2. The solar collectors can raise the water temperature from

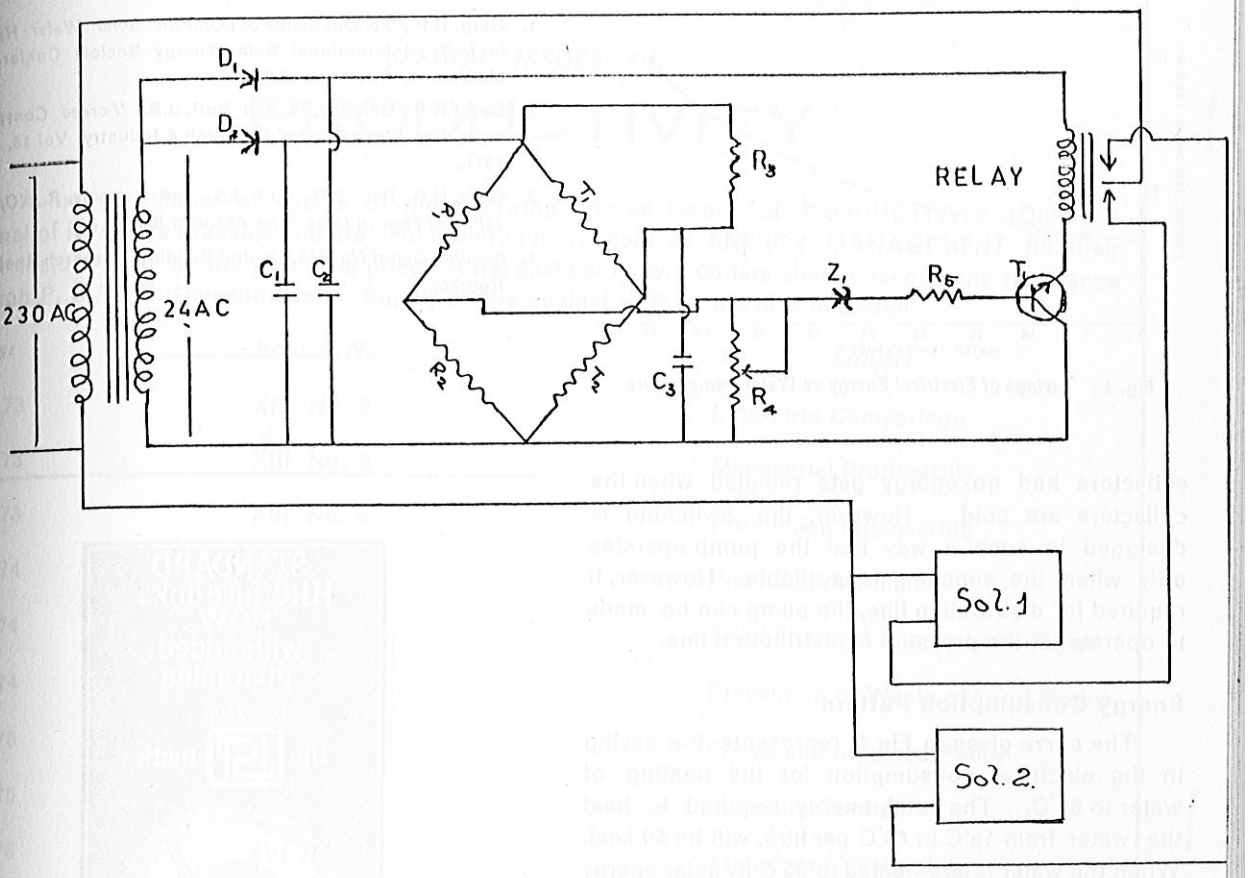

Fig. 3 : *Controls for Supplementary Water Heating by Solar Energy*

15°C to 55°C at the rate of 70 litre per sq. metre of the collector area. The requirment of the collector area can be worked out depending upon the amount of water required to be heated up. It is observed that 40% of the heat is lost in the pipe lines, etc. The temperature available at the inlet of the geyser will be around 35°C. Thus achieving a rise in water temperature by 20°C. However, the losses can be reduced by insulating the pipelines with 2.5 cm fibre-glass insulation. The extent of reduction of heat losses may be upto 20%.

Supplementary Water Heating System

Hot water from solar water heating system is fed to the geysers directly when the sunshine is available and the water may be used as such or may require a little eletrical heating for the desired temperature. The electrical heating is controlled by a thermostat and only the required amount electrical energy is consumed.

Automatic Controls

The differential thermostat is shown in Fig. Two thermistors T_1 and T_2 are used to sense t temperatures of the water in the collectors and t storage tank. A bridge having T_1 and T_2 as t two elements alongwith a switching circuit a relay forms the complete system. When the colle tor temperature is more than that of the stora tank the unit keeps solenoid (1) open and soleno (2) closed, and when the storage temperature more than the collector temperature, the switchi unit closes solenoid (1) and opens solenoid allowing the flow as shown in the flow diagra With the closure of solenoid (1), the water fr the storage tank does not circulate through t

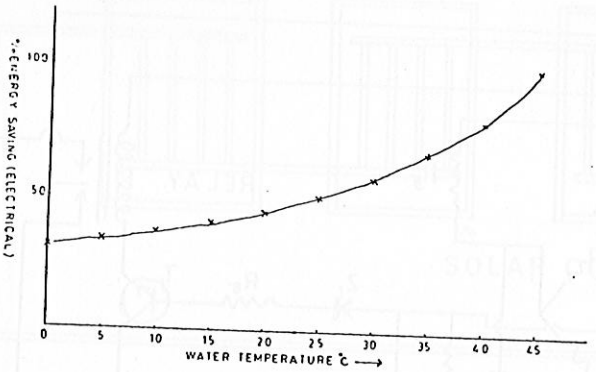

Fig. 4 : *Savings of Electrical Energy vs Water Temperature*

collectors and no energy gets radiated when the collectors are cold. However, the switching is designed in such a way that the pump operates only when the sunshine is available. However, if required for distribution line, the pump can be made to operate for the pressure in distribution line.

Energy Consumption Pattern

The curve given in Fig.4. represents the saving in the electrical consumption for the heating of water to 65°C. The total energy required to heat the water from 15°C to 65°C per litre, will be 50 kcal. When the water is pre-heated to 35°C by solar energy only 30 kcal will be the required electrical energy, thus saving the electrical energy by 40%. With the different inlet water temperatures the electrical energy requirements are different which can be observed directly from the curve. It has been estimated that for 1000 litre capacity installation the saving of electrical energy will be around 25 watt/hr. Whereas the initial cost with this installation will increase by 50%. The electrical consumption will be reduced by 40 to 50% after supplementing with solar energy.

Conclusion

The system is designed in such a way that the maximum amount of solar energy is utilised using the automatic controls, perventing the losses due to reradiation in the absence of sunshine and conserving the electrical energy from 30% to 100% at different inlet water temperatures.

References

1. Garg, H.P , *'Persent Status of Domestic Solar Water Heaters in India'*, International Solar Energy Society Conference, Melbourne, Australia, 1970.
2. Garg, H.P., Ganguly, R., and Puri, J.S., *'Forced Convection Solar Hot Water System'* Research & Industry, Vol 16, No.1. 1971.
3. Garg, H.P., Rao, K.R., Puri, J.S., and Ganguly, R., *'Optimization of Flow in large Solar Absorber Banks'*.
4. *Building Digest No. 115*, Central Building Research Institute, Roorkee.