Decentralized stand-alone Multi Effect Desalination (MED) system using fixed focus type Scheffler concentrator for the remote and arid rural regions of Sultanate of Oman

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Decentralized stand-alone Multi Effect Desalination (MED) system using fixed focus type Scheffler concentrator for the remote and arid rural regions of Sultanate of Oman

Parimal S. Bhambare1*, M. C. Majumder2, Sudhir C. V.3
1Senior Lecturer, 3Professor, Mechanical and Industrial Engineering Department, Caledonian College of Engineering, Sultanate of Oman.
2Professor, Mechanical Engineering Department, National Institute of Technology, Durgapur.

* Corresponding Author: parimal.bhambare@gmail.com

Abstract: Rising population and industrialization made desalination of prime importance in physically water scarce Sultanate of Oman for fulfilling the gap between the rising demand and supply of fresh water. Almost 80-85% of the installed and planned desalination plants in the Sultanate are based on Combined Cycle Gas Turbine (CCGT) power plants while remaining are standalone which includes about 5-7% of the installed plants for rural arid and dry regions. All the installed and planned desalination plants utilise fossil fuels for their operation and are based on Reverse Osmosis (almost 90-95% of the plants) and Multi Stage Flash technologies. Sultanate of Oman is a tropical country with most of the regions being arid and dry receiving solar energy most abundantly. But the utilisation of solar energy in the country is mostly limited to installations based on photovoltaic systems. Only recently solar thermal Enhanced Oil Recovery plant with 1 GWth power output has been undertaken in the country at Amal oil field. A pilot standalone Multi Effect Desalination (MED) plant using fixed focus type Scheffler concentrator for remote and arid rural regions of country has been discussed in this paper to address this gap. This pilot plant has been designed for producing 100 kg/day output based on three stage cross flow type multi effect desalination technology with two 16 m² Scheffler concentrators and operates in the temperature limits of 170 – 90°C. Preliminary testing carried out on the system during summer and winter period has shown that with available insolation above 700 W/m², steam at a pressure of 8 to 8.5 bar could be generated in a batch experiment after 2-3 hours from starting the operation for 42 to 55 kg of water in the header of the system. This steam generated is further utilised for desalination in three stages. The initial lag period for the system is measured to be 35-50 minutes depending on the quantity of water in the header, wind speed and solar insolation. System comes out of the lag period when solar insolation reaches just above 650-700 W/m². The desalination output for the system is measured between 60-65 litres per day for the summer period. Batch type intermittent operation, tracking errors, optical concentration losses, receiver convection losses, brine heat losses are few of the reasons observed based on the analysis for the lower output from the system. Experimentation has given a direction to make operation of the system from batch to continuous production while reducing optical and convection losses through appropriate rectifications for increasing overall yield of the system.
1. Introduction

Oman has experienced substantial increase in fresh water demand in the recent past due to rapid development that is taking place in the country, rising population, increased urbanisation and lifestyle improvement. This has caused the weakening of ground water resources, which ultimately lead to emerging of a large number of commercial desalination plants of different capacities in the country, predominantly working on reverse osmosis (almost 90-95 %) and thermal desalination principles. Furthermore, almost 90% and more of these plants are satisfying the fresh water demand of most of the urban population. According to the World Bank [1], nearly 2 barrels of crude oil have to be burnt per day to produce and supply desalinated water in individual GCC countries. Such high use of fossil fuels undermines the quality of air, increases GHG emissions (up to 400 million tonnes per year), and causes pollution. Furthermore, the unprecedented use of fossil fuels threatens the depleting oil and gas reserves in the country, and calls for alternatives to be implemented. Since the fossil fuels are fast depleting, non-renewable and affecting the country’s oil based economy together with the stringent greenhouse gas emission regulations coupled with target to lower the traditional energy requirements, country’s focus now needs to be shifted towards use of renewable energy based thermal desalination plants.

Many remote areas of the Middle East countries like UAE, OMAN especially those in Arabian Peninsula and other coastal line countries or some Mediterranean and Caribbean tourist islands are suffering from an acute shortage of drinking water [2]. These remote areas especially in Oman, depends on natural and ground water resources for their daily fresh water demands. Additionally, for these remote locations, the drinking water is generally hauled in by tankers or barges or produced by small decentralized desalination units using the available saline or brackish water. The studies of El-Nashar [2] reflects that the transportation of drinking water by tankers or barges involves a lot of expense and is fraught with logistical problems which can make fresh water not only very expensive [2] but also its supply being very susceptible to frequent interruptions [2]. Further, small and remote settlements in rural areas which are generally deprived from appropriate infrastructure do not profit from commercially available MED/MSF technologies. As these commercial desalination plants use complex technology and cannot easily be scaled down to the very small units and cater to the needs of local water demands [3]. The rural settings, generally lack of conventional energy resources as well as its distant connection to the national grid further more complicates the use of standard desalination techniques. Thus, the cost of energy is one of the major concerns for using conventional desalination to supply potable water to remote communities.

With the aim to provide a sustainable approach for desalination for remote as well as in the well-developed cities, the use renewable energy resources have become imperative. By far, the biggest renewable resource in MENA regions is solar irradiance, available in abundance everywhere in the region. MENA’s solar energy has a potential 1,000 times larger than its other renewable sources combined and is several orders of magnitude larger than the current total world electricity demand. MENA’s potential energy from solar radiation per square kilometre per year is equivalent to the amount of energy generated from 1–2 million barrels of oil [1]. Sultanate of Oman is a tropical country with most of the regions being arid and dry receiving solar energy most abundantly. The concentrating solar power (CSP)—can generate both heat and electricity. The Solar Concentrating power has advantage to store heat so it can provide energy for daylong desalination [1]. Thus utilizing solar energy for desalination through standalone and decentralised systems could be the most sustainable option for the remote and arid regions of country. Additionally these standalone and decentralised solar based desalination systems should be simple to operate, robust, maintenance free, does not demand skilled labour, independent of water salinity, does not demand any chemical pre-treatment for water and could be modular type to modify as per the requirements [2] [4]. Moreover these standalone decentralised type systems for its operation could be entirely based on solar energy for all its energy requirements namely thermal and electrical. A pilot standalone Multi Effect
Desalination (MED) plant using fixed focus type Scheffler concentrator producing 100 litres/day has been presented in this paper to address this gap. Few results based on the preliminary testing carried out have also been presented here.

2. Multi Effect Desalination (MED)

Multi effect distillation is a desalination process that takes place at lower temperatures by utilizing the latent heat of condensation from vapours of heated water in a series of vessels, also called effects which are maintained at a lower saturation temperature than the previous vessel. Since the temperature of saturated liquid water decreases when the vapor pressure is decreased, the vapor from the 1st effect chamber can be used for the next chamber, only the feed water chamber need an external energy source to heat the feed water. The MED system operates at an average top temperature of 70°C. Due to this MED is considered as one of the most suitable process to combine with solar thermal systems. Moreover, due to lower average temperature in the process the potential risk of scale formation in the plant also reduces but this increases the need for higher heat transfer areas.

There are many MED plants with medium to low capacity powered by the solar energy as source. A small MED plant with solar energy source consists of a tower with series of effects for heat exchange and a plate of solar collector where oil is used as a working fluid for transporting the thermal energy collected in the concentrator. The oil is circulated between the solar concentrator and the first effect chamber. The vapor from the first effect chamber gets condensed to the bottom of the second effect chamber and the condensed water is collected through a channel outside the plant unit. Figure 1 below shows the Multi Effect Desalination (MED) process.

MED offers few of the following advantages [6] over the other thermal desalination technologies such as MSF (Multi stage flash):
- Low energy consumption (less than 10 kWh/m³) compared to other thermal desalination processes.
- Operates at low temperature (< 70°C) and at low concentration (< 1.5) to avoid corrosion and scaling.
- Higher heat transfer coefficients with lower area requirements.
- Does not need pre-treatment of sea water and tolerates variations in sea water conditions.
- Highly reliable and simple to operate. Trained manpower is not required.
- Lower maintenance cost with higher product water quality.
- 24 hour a day continuous operation with minimum supervision.
- Can be adapted to any heat source, including hot water, waste heat from power generation, industrial processes, or solar heating.
- Suitable for operating between 0% and 100% capacity while MED unit is kept under vacuum and cold circulation as compared to MSF which cannot be operated under 60% of its capacity.
- Suitable to combine with renewable source like solar energy that supply intermittent energy.

As the MED systems operates at an average top temperature of 70°C. Due to this MED technology is considered as one of the most suitable process to combine with solar thermal systems over other thermal desalination technologies. Moreover, as mentioned above due to lower average temperature in the process the potential risk of scale formation in the plant also reduces.

3. Solar Energy potential for Sultanate of Oman
Oman being a tropical country with high ratio of sky clearness for almost 342 days/year [3] receiving higher solar insolation throughout the year and is considered to be one of the best destinations in the world for harnessing the solar energy. Majority of the land receives almost 2300 – 3500 W/m²/day in January and 5500 – 7300 W/m²/day in July as shown in Figure 2 [8]. Figure 3 shows that the annual solar irradiance in different regions of Oman varying between minimum 2050 kWh/m² to maximum 2500 kWh/m². Moreover, the average temperature for the country is 28.76°C while the average highest temperature reaches above 46°C at different locations. Locally at the interior in dessert temperature could even reach above 50°C also in the month of June-July. Although abundant potential is observed for solar energy applications, the utilisation of solar energy in Oman is mostly limited to installations based on photovoltaic systems. Only recently solar thermal Enhanced Oil Recovery plant with 1 GWth power output has been undertaken in the country at Amal oil field.

Solar energy can be fully or partially implemented in a desalination plant. By direct use of solar energy for the conversion of seawater or brackish water to be used for human purposes, solar energy can be the basis for desalination. Alternatively, solar energy can be simply used for heating purposes in thermal plants, as well as a power source for operating the conventional desalination plants [9].

4. Requirements of decentralised standalone desalination system for remote and arid regions
Oman has a large coastal area where people live in small villages at remote locations. Most of the remote regions are still dependent on traditional ground water sources supported by tankers or barges for satisfying their daily domestic water needs. About 5-7% of the total installed commercial desalination plants in the country are located near the villages to satisfy their fresh water demand.
But these are very few with lower capacities and could satisfy the needs of the few villages. Generally the desalination plants to be installed at these locations faces the following challenges:

4.1 Availability of conventional energy sources:
Availability of conventional energy sources at the location is limited due to remote location from the supply grid. Even the supply of conventional fuels such as natural gas or oil is not always guaranteed on continuous basis due to non-availability of supply pipelines, making the availability intermittent. The cost of transportation of conventional fuels itself is very high in terms the benefits obtained. Due to this, these installations may not be profitable in terms of the energy utilised and the desalination output.

4.2 Need for simple desalination technologies:
Most of the commercial desalination plants makes use of complex indirect desalination technologies for producing the fresh water. These technologies generally demands for pre-treatment plants and other technological requirements most frequently during their operation. Additionally few commercial desalination technologies such as Reverse Osmosis could be suitable for only brackish or low salinity water and requires frequent maintenance for high salinity water. The availability of the needful continuous technological support at remote locations may not be always guaranteed making the plant to shut down intermittently. Due to these reasons, the desalination technology utilised should be simple in operation, demanding almost negligible attention, involves less number of parts, very few technological requirements, should be robust, suitable for any water composition without any chemical pre-treatment requirements, higher conversion rates, with negligible maintenance and should be environment friendly to the local environment.

4.3 Availability of skilled technicians:
Due to remote locations of these regions and the population around is mostly skilled for the local requirements which may be fishing or else satisfying the daily local requirements. The desalination plants requires specially trained skilled technicians for operation of the plants which is generally
unavailable locally. This is one of the most important factors and needs to be addressed during initial planning itself.

4.4 **Challenging ambient conditions:**
As the country is tropical country, most of the regions are receiving high solar insolation with higher wind speed. Ambient temperature at the few location in internal dessert may reach to 55°C locally during summer. Dusty storms or wind carrying sand causing erosion are general issues needs to address during the planning.

4.5 **Modular type system:**
The system developed should be of modular type, in order to resize or scale satisfying the desalination requirements of the required number of population. This will make it more acceptable solution as a standalone and decentralised type desalination system.

4.5 **Economics involved:**
The above mentioned factors affects to the total cost of the desalinated water per litre and will be different for different regions based on their location from the energy sources and locally available support. Efforts should be made to make it economically self-sufficient in terms of the energy and operational requirements and the desalination output. The desalination plant essentially needs to be financed by the government for their long term economic sustainability.

5. **Solar thermal collectors:**
Solar thermal collectors are the equipments used to harness the solar thermal energy. Different solar thermal collectors are employed for enormous applications worldwide. Figure 4 below shows the comparison between them with their concentration ratio, tracking motion, absorber type and indicative temperature ranges:

| Motion                        | Collector type               | Absorber type | Concentration ratio | Indicative temperature range (°C) |
|-------------------------------|------------------------------|---------------|---------------------|-----------------------------------|
| Stationary                    | Flat plate collector (FPC)   | Flat          | 1                   | 30–80                             |
|                               | Evacuated tube collector (ETC)| Flat          | 1                   | 50–200                           |
|                               | Compound parabolic collector (CPC) | Tubular      | 1–5                 | 60–240                           |
| Single-axis tracking          | Compound parabolic collector (CPC) | Tubular      | 5–15                | 60–300                           |
|                               | Linear Fresnel reflector (LFR) | Tubular      | 10–40               | 60–300                           |
|                               | Parabolic trough collector (PTC) | Tubular      | 15–45               | 60–300                           |
|                               | Cylindrical trough collector (CTC) | Tubular      | 10–50               | 60–300                           |
| Two-axes tracking             | Parabolic dish reflector (PDR) | Point        | 100–1000            | 100–500                          |
|                               | Heliostat field collector (HFC) | Point        | 100–1500            | 150–2000                         |

**Figure 4** Solar Thermal Collectors configuration [10]

The selection of appropriate type of collector would depend on thermal efficiency at the desired temperature, energy yield, cost, and space occupied as the deciding factors. From all the possible collector’s configurations, a collector which can focus reasonably to a point with the concentration ratio nearer to 100 that can yield the temperature in the range of 100 to 500 (°C) is best suited for decentralized solar thermal desalination [11].

Scheffler concentrators are the fixed focus type collectors. As shown in Figure 5, it’s essentially a small lateral section of a large size paraboloid. The inclined cut produces a typical elliptical shape of the Scheffler reflector. Small segments of square sized mirrors attached on this lateral section makes the reflective surface of the Scheffler reflector. The sunlight falling on this reflective surface is
reflected sideways to the focus located at a distance. The axis of daily rotation is located exactly in north-south-direction, parallel to earth axis and runs through the centre of gravity of the reflector [14]. The main components of the Scheffler collector are primary reflector (The primary reflector is considered as the lateral part of a specific paraboloid) within an elliptical frame, a rotating support, tracking channel, reflector stand, and daily and seasonal tracking devices [11].

![Figure 5: Schematic of Scheffler Reflector][12]

Following are few of the advantages offered by Scheffler concentrators over other type of collectors:

- **Fixed focus collector**, focus is away from the concentrator suitably located as per the application requirement during design. Thus very convenient for domestic/industrial application requiring source availability inside the building.
- **Medium temperature range** between 300-400°C satisfying most of the industrial thermal requirement including desalination.
- **Focus temperature** can reach above 400°C depending on the size of the reflector, the concentration ratio and solar irradiance.
- As absorber is away from the concentrator placed at the focus, it is simple in construction as compared to parabolic dish reflector/ trough collector.
- **Easy to construct** at site with available material and local unskilled manpower.
- **Installation is fast** and can be brought to operation in less than 2-3 working days (for a 16 m² Scheffler concentrator).
- **Simple automatic tracking system**. Hassel free system in terms of its operation as it requires almost negligible control except seasonal adjustments.
- **System is almost balanced** in terms of its mechanical loads and requires almost very less capacity motor which can be operated by comparatively lower capacity photovoltaic panel mounted on the system itself. Thus self-sufficient in terms of additional energy requirement.
- **Comparatively less costly** due to lesser transportation and logistics cost, simpler tracking system, lower cost locally available materials used for construction, easy installation, etc.
- **Lower operational cost** due to easy operational and maintenance. Unskilled workers/housewives can operate with simple training.
- **Maintenance is easy** except problems like breaking of mirrors, tracking etc. as compared to other solar concentrating technologies.
- **Long term operation** without any specific/complicated maintenance issues is possible.
- **Most suitable for standalone applications** in remote locations requiring thermal energy as input such as desalination plants.
- **Effectively employed for majorly solar cooking applications worldwide.**
Considering all the advantages offered by the Scheffler collector, this type of collector is considered as the most suitable and viable selection among the rest of collectors for the standalone type desalination application.

6. The System Configuration:
The system has been designed for 100 kg/day as the desalination output. The system has been designed to operate between 150°C to 100°C in first two stages and the last stage is operated at vacuum so as to have the evaporation less than 90°C. The receivers, header and the header pipelines constitutes the primary circuit of the system that uses distilled water as the working fluid. The header operates at an average pressure of 8 bar. The saline or brackish water is filled in three stages of the system that forms the secondary circuit of the system. First stage receives the heat from the header which is used for latent heating and vaporisation. The vapours generated in the first stage are condensed in the second stage transferring its latent heat to the sea water in the second stage. This further produces the vapours that are transferred and condensed in third stage. Pressure reduces from first stage to third stage gradually. Vapours generated in third stage are condensed directly through a feed water preheater to obtain the condensate as the desalted water. Brine from all stages is collected together and discarded to drainage after treatment. Condensate from first two stages is collected together to obtain as the desalted water.

The initial simplified mathematical model for the system has been envisaged based on the fundamental energy and mass principle using the steady state analysis. Following assumptions have been made while developing the model:

- Pure water properties; both thermal and physical are considered instead of saline water for the analysis.
- All the properties are evaluated at the average or bulk mean temperature in the respective stage or the surface temperature of the system.
- Thermal losses to the environment are assumed to be as single function. Pressure losses in the pipelines are neglected.
- System works for 5 hours a day with clear sky. Effect of clouding is not considered during the analysis.
- Average solar insolation considering 5 hours of working from 9 am to 2 pm has been considered for the analysis.
- Average ambient temperature and wind velocities between 9 am to 2 pm have been considered while calculating the thermal losses from the system to surroundings.
- The overall average conversion ratio for all stages is assumed to be 30% for initial design of the system.
- Effect of Boiling Point Elevation (BPE) is not considered.

The mathematical model developed has been used to finalize the number of effects required for obtaining desalination output of 100 kg/day through an iterative steady state analysis process. Figure 6 below shows the mass and energy balance analysis for the three stage cross flow type multi effect desalination system.

The heat collected at the receivers \(Q_{in}\) from the Scheffler concentrators is available as heat input for the first stage, thus the energy balance equation at this stage can expressed as in equation 1 below,

\[
Q_{in} + m_{1feed} \times C_p \times \Delta T_{1 feed} = m_{e1} \times C_p \times (T_{1 sat} - T_{1 feed}) + m_{e1} \times h_{fg1} + m_{b1} \times C_p \times (T_{1 sat} - T_{1 feed}) + Loss_{1}
\]  

(1)
The heat balance in stage 2 and 3 is as below,

\[
m_1 \times h_{f} + m_{2, feed} \times C_p \times \Delta T_{2, feed} \\
= m_1 \times C_p \times (T_{2, sat} - T_{2, feed}) + m_2 \times h_{f} + m_{3, feed} \times \Delta T_{3, feed} \\
+ Loss_2 \\
m_2 \times h_{f} + m_{3, feed} \times C_p \times \Delta T_{3, feed} \\
= m_3 \times C_p \times (T_{3, sat} - T_{3, feed}) + m_3 \times h_{f} + m_{3, feed} \times \Delta T_{3, feed} \\
+ Loss_3
\]

(2)

Figure 6 Mass and energy analysis for three effects/stages evaporation desalination model

The mass balance for each stage is,

\[
m_{feed1} = m_1 + m_{b1} ; \\
m_{feed2} = m_2 + m_{b2} ; \\
m_{feed3} = m_3 + m_{b3} ;
\]

Heat lost to brine water from all stages,

\[
Q_{brine} = m_{b1} \times C_p \Delta T_{brine} + m_{b2} \times C_p \Delta T_{brine} + m_{b3} \times C_p \Delta T_{brine}
\]

Number of Scheffler concentrators required for the desalination process has been estimated based on the total heat required for the process, heat losses, average solar insolation of 500 W/m² and overall concentration losses at the Scheffler and receiver.

Where,

| Symbol | Description |
|--------|-------------|
| m_{feed}, m_{2, feed}, m_{3, feed} | Mass flow rate of feed water (kg/day) at stage 1, 2 and 3 at 30°C |
| m_{b1}, m_{b2}, m_{b3} | Mass flow rate of brine water (kg/day) at stage 1, 2 and 3 (Assumed m_{b} = 70% of mass flow rate of feed water) |
| m_{1}, m_{2}, m_{3} | Mass flow rate of steam (desalinated water) in kg/day at stage 1, 2 and 3 (Assumed m_{s} = 30% of mass flow rate of feed water) |
| Q_{in} | Heat energy input from the header (kJ) for system |
| Q_{out} | Heat carried away by the brine in kJ from all stages of the system |
| C_{p} | Specific heat of water, kJ/kgK |
| h_{fg1}, h_{fg2}, h_{fg3} | Latent heat of vaporization for water (kJ/kgK) in stage 1, 2 and 3 at respective pressures |
The final technical specifications of the system are as below:

| Number of effects used | 03 |
|------------------------|----|
| Number of Scheffler concentrators | 02 |
| Size of each Scheffler | 16 m² |
| Tracking used | Continuous and automatic |
| Desalination output | 100 kg/day |
| Conversion ratio | 30% |
| Header Pressure | 8 bar |
| Pressure in stage 1 and 2 | 5 and 2 bar |
| Pressure in stage 3 | 0.3 bar |
| Total mass of feed water required, m_{feed} | 375 kg |
| Total mass of distilled water in header, m_{header} | 120 kg (includes 40% water in pipelines and receivers) |

7. Experimental results and discussion:
The designed system is manufactured and installation has been done at author’s institute. Figure 7 below shows the pictorial view of the installed desalination plant.

![Figure 7 Pictorial view of the installed desalination plant](image)

Experiments have been conducted on the system for summer and winter period. Based on the analysis carried out, following results are obtained:

7.1 Thermal Lag period:
The time period from the beginning of the experiment until the first considerable rise in pressure recorded in the header column due to steam generation is considered as thermal lag period. The span
of lag period is dependent on the solar insolation upon the two receivers. The output of lag period calculation is determined from the variation in header pressure throughout the experiment time. Figure 8 & 9 shows the variation of solar insolation and the header pressure rise with time of the day with lag period.

![Figure 8](image1.png)  
**Figure 8** Variation of Solar insolation (W/m²) with time of the day

![Figure 9](image2.png)  
**Figure 9** Variation of Header Pressure (bar) with time of the day

The lag period was also calculated for different water levels in the header. Thermal lag period depends on the solar insolation on the day, the water level in the header, the ambient conditions and the temperature of the water in the header at start of the experiments. Thermal lag period for the system was calculated for summer and winter period. The average thermal lag period when solar insolation rises above 650-700 W/m² in winter has been estimated to be 50 - 55 minutes while for summer the lag period reduces to 25-35 minutes.

### 7.2 Batch Desalination output:
Desalination output from the system has been measured by running the system in batch type experimentation carried between 8:30 am to 2 pm. The average pressure in header and first two stages is varied in 4 batches as shown in Figure 10. Pressure is allowed to rise up to maximum of 8 bar in
header and first output is taken. Again the pressure is allowed to reach to the maximum pressure possible and the output is taken and so on. Similar procedure is adopted at stage 1 and stage 2. Pressure at stage 3 is maintained to 0.3 bar throughout the experiment. The total desalination output from all the stages including stage 3 is measured as 63.6 kg for the day.

![Graph showing pressure vs time](image)

| Stage | Desalination output, kg |
|-------|-------------------------|
|       | Stage 1 | Stage 2 | Stage 3 |
| Batch 1 | 6.4     | 3.7     |         |
| Batch 2 | 9.8     | 4.1     |         |
| Batch 3 | 11.9    | 5.2     | 2.8     |
| Batch 4 | 13.1    | 6.6     |         |
| Total output | 41.2    | 19.6    | 2.8     |

**Figure 10** Batch type experimentation and the desalination output

8. **Conclusion:**

Almost all the remote and arid locations of Sultanate of Oman receives abundant solar energy throughout the year. Most of the remote regions are still dependent on traditional ground water sources supported by tankers or barges for satisfying their daily domestic water needs. Scheffler concentrator based cross flow type multi effect desalination system pilot desalination plant producing 100 kg/day discussed in this paper to address this issue. Requirements of remotely located regions with limitations are also discussed here. Scheffler concentrators offers several advantages for operating thermal desalination system in these remote regions. Preliminary design and few experimental results have been presented. The designed system has been tested for the batch type operation using the saline water at author’s institute for summer and winter period. Based on the preliminary testing of the system following conclusions have been drawn:

- Scheffler concentrator’s can be suitably applied as the thermal energy source for operating thermal desalination systems.
- Average thermal lag period for the system has been observed to be 35-50 minutes when the solar insolation rises above 650-700 W/m².
- Desalination output of 60-65 kg/day has been measured from the system during summer period.
- Batch type intermittent operation, tracking errors, optical concentration losses, receiver convection losses, brine heat losses are few of the reasons observed based on the analysis for the lower desalination output from the system.

Experimentation has given a direction to make operation of the system from batch to continuous production while reducing optical and convection losses through appropriate rectifications for increasing overall yield of the system.

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