INTERNATIONAL MULTIDISCIPLINARY JOURNAL FOR RESEARCH & DEVELOPMENT
SJIF 2019: 5.222 2020: 5.552 2021: 5.637 2022:5.479 2023:6.563 2024: 7,805
eISSN :2394-6334 https://www.ijmrd.in/index.php/imjrd Volume 12, issue 06 (2025)

ANALYSIS OF SCHEMATIC AND TECHNOLOGICAL SOLUTIONS OF HYBRID (SOLAR-FUEL) POWER PLANTS AND ELECTRIC POWER STATIONS

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Solar power plants (SPP) allow the generation of electrical and thermal power on an energetically tangible scale without negative impact on the environment.

In modern solar energy, two main types of thermodynamic solar power plants can be distinguished: tower and modular types. The concept of creating thermodynamic tower-type solar power plants was developed in the 1950s at ENIN named after G. M. Krzhizhanovsky.

The ten-year period of development, construction, launch and pilot industrial operation of solar power plants of various types, which began in the mid-70s, immediately after the first world "energy crisis", and was essentially completed in developed countries by the end of the 80s, provided extensive material. Solar-1 in the USA, Yurelios in Sicily, NIO in Japan, Tsega-1 in Spain, Themis in France, SES-5 in Crimea and other solar power plants built allowed us to conclude that, according to all forecasts, tower-type solar power plants are unlikely to become competitive in the next 10-15 years and will require further development.

Considerably greater success is expected in the development of modular solar power plants with parabolic trough collectors. Evidence of this is the work of the American-Israeli company "Luz", which, despite the unfavorable situation, created a series of highly efficient and reliable modular parabolic trough stations of industrial level with a total capacity of about 300 MW. By 1994, the total capacity of solar stations of the company "Luz" reached 600 MW. [6] The main elements of the SEGS are: a field of parabolic trough collectors, an energy unit and a water treatment system. At SEGS I, the heat generated by the parabolic trough field was first fed to the storage tank, and then, after heating in a gas superheater, to the turbine. In the following SEGS projects, there are no storage tanks, with the exception of insignificant heat generation provided by the expansion vessel. This means that the operation of the power unit is directly related to the field generation. The station has a two-stage turbine: high pressure with superheated steam and low pressure with two heaters before feeding. High-pressure steam enters the turbine from a gas boiler (pressure 100 atm, temperature 510°C), or from a solar field (pressure 100 atm, temperature 370°C), or from a combination of these sources (hybrid operation). After the high-pressure stage, the steam is again heated by the solar field, in the gas boiler or in both, and then enters the low-pressure stage. The cooling system of the station is a tubular condenser - a cooling tower. The waste water in the cooling tower and water treatment device enters the evaporation pond.

Table 1

Characteristics of SEGS I - VIII of the company "Luz" [6]

Station	Start exploitation, year	Power turbines, MW	Temperature at the exit of the solar field, °C	Efficiency turbine cycle, %		General square collectors, m^2	Square single module, m^2
				solar boilers	offgas boiler		
SEGS I	1984	13.8	307	31.5	-	82960	128

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SEGSII	1986	30	315	29.4	37.0	165376	128
SEGS	1987	30	349	30.6	37.4	203980	233
SEGS IV	1987	30	349	30.6	37.4	203980	233
SEGS V	1988	30	349	30.6	37.4	233120	233
SEGS VI	1989	30	390	37.5	39.5	188000	545
SEGS	1989	30	390	37.5	39.5	183120	545
SEGS	1990	30	390	37.5	39.5	-	545

The solar field is a parallel arrangement of parabolic trough collectors. Luz has developed three generations of solar parabolic trough collectors: LS -1, LS -2 AND LS -3.
Collectors LS -1 AND LS - 2 are assembled from formed mirror panels of a simple system in the form of a tray and a screw pipe, which support the mirrors and ensure the independence of the reflecting surface. The panels are designed taking into account the angle of coverage of 80° and the concentration coefficient of 61÷71. Due to the high precision of panel manufacturing and assembly, 97% of the reflected rays are captured by the receiver. The heat receiver is made of a stainless steel pipe with a chrome selective coating and surrounded by an evacuated glass pipe. The receiver also includes glass-metal seals, metal bellows and gas absorbers (getters).
Table 2
Characteristics of solar collectors from the company "Luz"

Parameter	LS -1	LS -*2*	LS - 3
Area, ^{m2}	128	233	545
Mirror segments, pcs.	64	120	224
Aperture: width, m length, m	 2.55 50.2	 5.0 47.1	 5.76 96.3
Heat receiver diameter, m	0.042	0.07	0.07
Average focal length, m	0.94	1.84	2.12
Distance between rows, m	7.3	12.5	17.3
Optical efficiency, %	73.4	73.7	77.2
Operating temperature, °C	308	349	391
Emissivity receiver at temperature:	300 0.30	300 0.24	350 0.18
Receiver absorption coefficient	0.94	0.94	0.96
Receiver transmittance	0.94	0.94	0.945
Reflectivity of mirrors	0.94	0.94	0.94
Peak receiver efficiency, *%*	66	66	68
Annual thermal efficiency, %	51	51	53
Degree of concentration	61	71	82

The solar collector installation system has a design accuracy of 0.1. The closed-loop tracking system is based on the readings of the sun-receiving element. The sun-receiving element is equipped with a convex lens that focuses the light on two conventional photocells with a resolution of 0.06 degrees. Cloudiness, fog and dust have been proven to have no effect on the sun-receiving element. A motor with a 1500:1 gearbox is used to rotate the collectors, which ensures the necessary accuracy when focusing the system.

The mirror panel and the solar collector drive mechanisms are designed to operate under normal conditions and with precision at wind speeds up to 32 km/h and with less precision at 72 km/h. At night, at high wind speeds or in other cases when the field is not in operation, the collectors are folded face down for protection.

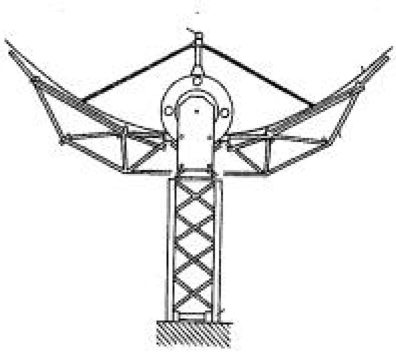

Fig. 1.1. Parabolic cylindrical collector Ls – 3 from the company "Luz" [6]

Fig. 1.1 shows the design of the Ls -3 collector. The Ls -3 COLLECTOR is twice as long as the Ls - 2 collector, its aperture is 14% wider, which reduces the number of moving hoses, microprocessors, temperature sensors and associated equipment by more than 2 times. The Ls -3 collector was designed taking into account high mechanical loads. The assembly of the Ls -3 is the main point of the design, which is carried out using a template and fine-tuned before final assembly. As a result, the collector structure is stronger and lighter, has improved optical characteristics and operates with high accuracy in strong winds. Ls -3 is rotated by a three-phase asynchronous electric motor with a 2100:1 gearbox. The Ls -3 heat receiver is identical to the Ls - 2 element, but has an improved optical characteristic, which allows generating steam with higher pressure and temperature. The solar field control system consists of a field dispatch control system located in the central control room, locally located in each collector. Mirrors are washed at night according to a developed procedure with a frequency of two to three weeks. The service life of solar stations from Luz is up to 30 years.

Fig. 1.2. Solar thermal power plant " Solar Energy Generating Systems " in California with a capacity of 354 MW

In Almeria (Spain), the trial operation of a 500-kilowatt modular station on parabolic trough collectors, built for the purpose of comparison with a tower-type solar power station [7], has been completed. Fig. 1.3 shows the basic diagram of the solar power station. The station consists of two types of parabolic trough collectors. Thermal energy collected by steam in parabolic trough collectors (the working fluid is high-temperature oil) is pumped to the upper part of the storage tank, from where it can be taken to the steam generator, where steam is produced for the steam turbine. Low-temperature oil returns from the steam generator to the bottom of the main storage tank, and then to the collector field.

The first collector field consists of single-axis parabolic trumpet collectors from the company "Acurex" (USA), model 3001, occupying an area of 2674 m2 and oriented east-west. A thin glass mirror with a thickness of 0.6-0.8 mm, possessing good optical properties, is used for the collectors. The second field is equipped with collector modules from the company MAN (Germany) with a total area of 2688 m2 ; models "Gelioman 2/32" with two-axis tracking, consisting of two-sided mirrors with a thickness of 4-5 mm, made of sheet glass by the hot forming method. The third field, occupying an area of 2240 m2 , equipped with the same type of "Gelioman", but significantly improved, was installed at the station in March 1984. The total area of collectors at the station was 7602 m^2 .

Fig. 1.3. The 200 MW Golmud Solar Park located in Qinghai Province, China

The steam turbine for the modular station is an eight-stage condensing turbine with one extraction stage for the deaerator.

The experience gained from operating two types of collectors used in a modular power plant has shown that biaxial collectors, despite a high percentage of solar energy capture in the early morning or late evening, have some disadvantages. These include high capital investments, high maintenance costs, and high heat losses in the passive pipes of the collector field. During normal field operation (inlet oil temperature of 215°C, outlet oil temperature of 290°C), the total heat energy losses of the field were estimated at 620 kW for a biaxial tracking system and 350 kW for a single-axis system, which is 23 and 11% of the total incident solar energy, respectively. A biaxial collector field collects 50% more solar energy than a single-axis tracking field, but the total amount of generated heat energy is only 16% higher, which is explained by the high heat losses in the passive pipes. The passive pipe length is 2.37 times longer than the active pipe length for biaxial tracking systems, and 0.49 times longer for single-axis systems. Improvements made in the design and installation of the new and second biaxial collector field have resulted in a minimum passive pipe length, improved insolation, and the new field control concept has reduced heat loss and significantly increased the conversion efficiency. As a result, the field is capable of producing more thermal energy, the amount of which was estimated to be 10% higher on clear days and even more on days with low solar radiation levels.

In general, the experience of operating the stations has shown that the thermal energy generated by the collector fields on the spring equinox is approximately 40% greater than in winter. Starting thermal losses on a clear winter day amounted to 6% of the total energy generated by the field, and if the system was completely cold, it reached 15%. Electricity generation on one clear summer day is about 2.1 MW·h, and on a clear winter day about 1.35 MW·h. In the near future, with the help of fairly obvious improvements in such areas as optical characteristics and heat transfer in the collector field, battery subsystem, in the energy conversion system, it will be possible to achieve a resulting efficiency of about 15%, and with additional flexibility in regulating operating conditions, 17-19% can be expected. The daily efficiency of the energy conversion system is expected to be about 25%. The Austrian Federal Office for Science and Research has built and tested a 10-kilowatt parabolic trough power plant for developing countries [8]. The operating principle of the plant is that the coolant—water—circulating in the primary circuit is heated in solar parabolic trough collectors to 140°C and enters the heat exchanger, where the working fluid—freon-113—evaporates, driving the turbine. The parabolic trough collectors are installed on 10 parallel-connected frames with a common hot and cold water distribution system. Each frame contains 12 parabolic trough modules installed and connected in series. The dimensions of a single module are 3.0 x 1.0 m. The total surface area of the collector field is 360 m^2. The collector receiver is a selectively colored steel pipe surrounded by a glass- transparent shell. The collector tracking system is automatic; the rotation of the collectors is achieved by means of a specially designed gear transmission. The collector field is oriented at an angle of 30° to the horizon in the north-south direction. In order to neutralize fluctuations in heat supply from the group of collectors and to ensure the operation of the station at night, a heat accumulator is provided in the system. It is a tank thermally insulated with 50 mm thick fiberglass and filled with hot water at a temperature of ~125°C. A small radial turbine (radial inlet and longitudinal outlet) with a nominal power of 15 kW, a speed of 42,000 rpm and an efficiency of 70% is selected as the prime mover.

LIST OF REFERENCES

1. Туляганова, В. С., Абдуллаева, Р. И., Негматов, С. С., Туйчиева, М. О. К., Шарипов, Ф. Ф., & Валиева, Г. Ф. (2021). Исследование процесса спекаемости электрокерамических композиций. *Universum: технические науки*, (10-4 (91)), 43-46.
2. Туляганова, В. С., Абдуллаева, Р. И., Туйчиева, М. О., Умирова, Н. О., & Аззамова, Ш. А. (2021). Петрографическое и рентгенографическое исследования керамических композиций на основе местного сырья. *Universum: технические науки*, (8-2 (89)), 79-83.
3. Qizi, T. M. O. (2023). Gidroelektr Stansiyalarning Ishlash Prinspi. *Ta'lim fidoyilari*, *21*, 97-101.
4. Toychiyeva, M. O. (2022). Development of Effective Compositions and Studies of the Properties of Magnesium-Steatite Electro ceramic Composite Materials Based on Local Raw Materials.
5. Туляганова, В. С., Абдуллаева, Р. И., Туйчиева, М. О., Умирова, Н. О., & Аззамова, Ш. А. (2021). Разработка и исследование керамико-технологических и диэлектрических свойств композиционных электрокерамических материалов. *Universum: технические науки*, (8-2 (89)), 84-88.
6. Toychiyeva, M. (2023). EDIBON SCADA EESFC Qurilmasi Orqali Quyosh Panellarini Volt Amper Xarakteristikasini Olish. *Solution of social problems in management and economy*, *2*(1), 89-94.
7. Toychiyeva, M. (2023). КЛАСТЕР ЁНДАШУВИ АСОСИДА ПЕДАГОГИК ТАЪЛИМ СИФАТИНИ БОШҚАРИШ ВА РАҚОБАТБАРДОШЛИГИНИ ТАКОМИЛЛАШТИРИШ. *Theoretical aspects in the formation of pedagogical sciences*, *2*(2), 196-203.
8. Туйчиева, М. (2022). Методы И Средства Контроля Показателей Качества Электрической Энергии. *PEDAGOGS jurnali*, *6*(1), 429-433.

9. Tuychiyeva Mahliyo Obidjon Kizi, . (2021). Aluminum Oxychloride For Coagulation More Effective Coagulant For Water Purification. The American Journal of Interdisciplinary Innovations and Research, 3(05), 192–201. https://doi.org/10.37547/tajiir/Volume03Issue05-31

10. Юсупов, О. Я., Зокирова, Д. Н., Тойчиева, М. О., & Мухиддинова, Ф. Б. (2019). МЕТОДЫ И СРЕДСТВА КОНТРОЛЯ ПОКАЗАТЕЛЕЙ КАЧЕСТВА ЭЛЕКТРИЧЕСКОЙ ЭНЕРГИИ. *Экономика и социум*, (3), 512-515.

11. Туйчиева, М. О. (2024). ЭНЕРГЕТИЧЕСКАЯ ЭФФЕКТИВНОСТЬ СОЛНЕЧНО–ТЕПЛОВЫХ ЭЛЕКТРОСТАНЦИЙ. СОВРЕМЕННОЕ СОСТОЯНИЕ ИССЛЕДОВАНИЙ ТЕХНОЛОГИИ ИНТЕГРАЦИИСОЛНЕЧНЫХ КОНЦЕНТРАТОРОВ В ТЕПЛОВУЮ СХЕМУ СУЩЕСТВУЮЩИХ ТЭС. *Экономика и социум*, (5-2 (120)), 1405-1411.

12. qizi To'ychiyeva, M. O. (2024). BUGUNGI KUNDA ENERGIYA TEJAMKOR MUQOBIL ENERGIYA MANBALARIDAN FOYDALANISH ISTIQBOLLARI VA UNING ZARURATI.

13. Тўйчиева, М. О., Солиев, Р. Х., Кахарова, М. А., & Маннонов, Ж. А. (2022). СТЕАТИТЛИ ЭЛЕКТРОКЕРАМИКА МАТЕРИАЛЛАРИНИ ОЛИШ УЧУН МАҲАЛЛИЙ ХОМАШЁЛАРИНИНГ КИМЁВИЙ ВА МИНЕРАЛОГИК ТАРКИБИ ВА ХОССАЛАРИНИ ЎРГАНИШ. *Academic research in educational sciences*, *3*(4), 45-50.

14. Tuychiyeva, M. O., Muxammadaliyeva, H. N., & Sharapatov, A. I. (2025). Технологические процессы и схемы, впу применяемые при очистке воды ТЭС. *Строительство и образование*, *4*(3), 166-171.