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Design and Development of 360° Solar Air Cooler

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INTRODUCTION

The air cooling is one of the earliest methods employed by men for conditioning their houses. Only in recent years, it has been put on sound footing thermodynamic. It is a process of adiabatic saturation of air when a spray of water is made to 360-dergree into it without transfer of heat from or to the surroundings. The initial investment cost of such a system is low & the operation is simple & deep.
Simple 360-degree cooling is achieved by direct contact of water particles & a moving air steam. If the water is circulated without a source of heat & cooling, dry air will become more humid & will drop in temperature. The air may be sufficiently cooled by 360 this process to results a considerable degree of summer comfort in climates high dry-bulb temperatures associated with low relative humidity. The minimum outdoor temperature required for successful 360-degree cooling is above 360 c & another requirement is a relatively low 360-degree air cooling is upgraded version of conventional type of air coolers. By doing some modifications in normal air cooler, more efficient can be obtained. The 360-degree air cooler distributes air in all directions which makes it efficient as cooling is provided till a particular radius. More area is covered by this air cooler and it will operate on both solar as well as AC supply.

LITERATURE REVIEW

K.V.R. Manikanta: Fabrication Of Solar Air Cooler
Mechanical Engineering without production and manufacturing is meaningless. Production and manufacturing process deals with conversion of raw materials inputs to finished products as per required dimensions, specifications and efficiently using recent technology. The new developments and requirements inspired us to think of new improvements in air conditioning engineering field.
In our project, solar power is captured and stored in the battery. This power is used to run the air cooler whenever required. Solar energy means the radiation energy that reaches the earth from the sun. It provides daylight makes the earth hot and is the source of energy for plants to grow. Solar electric systems are suitable for plenty of sun and are ideal when there is no main electricity. Solar electricity is the technology of converting sunlight directly in to electricity. It is based on photo-voltaic or solar modules, which are very reliable and do not require any fuel. Our objective is to design and develop a solar electric system namely "fabrication of solar air cooler".
Krishnan Kumar: DC Blower Motor Operated Cooler with Solar Panel
Cooler with solar panel for residential cooling is very important during the summer as well as in the life to maintain the food, fish, and many items at constant temperature to avoid the bad effect of viruses. But air cooling is very important part during the summer for a man. Cooling process employs the different method to cooling the air. Today air cooling method as very expensive for AC coolers, air conditioning, fans and dehumidifiers. To running these products required AC supply/electrical. The generation of electrical power ultimately responsible for hot and humid environments which causes global warming. Air conditionings, refrigeration, air cooling system are rapidly increased due to hot and humid conditions that provide us a relaxed and comfortable life. But these products and source are not available every time and villages. DC battery and solar power system are more suitable for the purpose. Solar and DC system being considered as one of the path towards more sustainable energy system. Blower motors are used in this cooler for fan and water pump which gives us cooling air. This projects and research of DC and industrial applications.
Vijay Kumar Kalwa: Modelling and Fabrication of Solar Powered Air Cooler with Cabin for Household Food Items
In hot and humid conditions, the need to feel relaxed and comfortable has become one of few needs and for this purpose utilization of systems like air-conditioning and refrigeration has increased rapidly. These systems are most of the time not suitable for villages due to longer power cut durations and high cost of products. Solar power systems being considered as one of the path towards more sustainable energy systems, considering sola-cooling systems in villages would comprise of many attractive features. This technology can efficiently serve large latent load and greatly improve indoor air quality by allowing more ventilation while tightly controlling humidity. Despite increasing performance and mandatory energy efficiency requirements, peak electricity demand is growing and there is currently no prevalent solar air cooling technology suited to residential application especially for villages, school and sand offices. This project reviews solar powered air cooler with cooling cabin for house hold food items hence their viability for residential application.
Prof. Raman Kumar: Design and Fabrication Of 360 Cooler Cum Heater
This paper is based on innovation to conventional coolers. In conventional or normal cooler we get one directional air flow only. This cooler is designed in such a way that the people sitting in any area in the room get equivalent cooled air. The cubical cooling

chamber consists of four cooling pads. The exhaust fan in mounted above the chamber, below with the heating coil is mounted. Thus this cooler can be used as a heater in the winter season and as a cooler in a summer season.

Guide Prof. Shrikant D Jadhav: Manufacturing of 360 Degree Rotation Air Cooler

Energy demands are expected to be more than double by 2030, and there is a pressing need to develop ways to conserve energy for future generation. Thus energy consumption can be reduced drastically by using energy efficient appliances. In India, the union ministry of power's research pointed out that about 20-25% of the total electricity utilized in government buildings in India is wasted due to unproductive design, resulting in an annual energy related financial loss of about Rs 1.5 billon. Conventional heating ventilation and air conditioning system (HVAC) consume approximately 50% of the building energy. This type of air conditioning is therefore neither eco-friendly nor sustainable. Selection of paper air conditioning system for buildings can not only help the country save electrical energy but also reduce greenhouse emissions. An evaporative cooler (also swap cooler, desert cooler and wet air cooler) is a device that cools air through the evaporation of water. Evaporative cooling differs from typical air conditioning systems which use vapour-compression or absorption refrigeration cycles. Evaporative cooling works by exploiting water's large enthalpy of vaporization. The temperature of dry air can be dropped significantly through the phase transition of liquid water vapour (evaporation), which can cool air using much less energy than refrigeration. In extremely dry climates, evaporative cooling of air has the added benefit of conditioning the air with more moisture for the comfort of building occupants.

Vijay Kumar Kalwa: Design and Development of Solar Powered Air Cooler

The present air cooling methods are evaporative coolers, air conditioning, fan and dehumidifiers. But running these products needs a source called electricity. The producing of electricity is ultimately responsible for hot and humid conditions i.e. global warming. In hot and humid conditions, the need and to feel relaxed and comfortable has become one of few needs and for this purpose utilization of systems like air-conditioning and refrigeration has increased rapidly. These systems are most of the time not suitable for villages due to longer power cuts durations and high cost of products. Solar power being considered as one of the path towards more sustainable energy systems, considering solar-cooling system in villages would comprise of many attractive features. This technology can efficiently serve larger latent loads and greatly improve indoor air quality by allowing more ventilation while tightly controlling humidity. Despite increasing performance and mandatory energy efficient requirement, peak electricity demand is growing and there is currently no prevalent solar air cooling technology suited to residential application especially for villages , schools and offices. This project reviews solar powered air cooler residential and industrial applications.

Hamdy Youssef Hussein Aly: Maximizing Range Using Ultrasonic Sensor and Arduino

This paper explains how to optimize the ultrasonic sensor's work in detecting and measuring distance and obstacle characteristics underwater using a microcontroller Arduino. On of the most significant challenges of underwater studies is the difficulty for operators to navigate remotely operated vehicles (ROVs) in surrounding where visibility is partially or entirely obstructed. As a solutions, a video camera is attached in front of the vehicle and stream the video real-time using a computer operated monitor on the surface. However, set-up and installation may be very complicated and expensive. Instead, we explore the use of a more straightforward and less costly way for visual feedback: the ultrasonic sensor or Sonar (sound navigation and ranging). A single transducer was used to communicated and supply the power needed by the ultrasonic sensor. The sensing procedure is based n the measurement of ultrasonic pulse's travel time from the target object submerged under water. The sonar was waterproofed before sinking in the water to achieve th desired output. Any hindrances to maximize the desired results were eliminated. The result shows that the sensor delivered significantly information about the relative proximity of the obstacles against the ROV when all the testing requirements were met.

Vishal M. Barde, Govind R. Bathe: Modification and Development in Air Cooler

In Conventional Air Cooler, the outside air comes in contact with the water on the cooling pads. This outside air gives latent heat of vaporization to the water. Due to this water evaporates and that vapour gets mix with the air and thus the humidity of the air has been increased. This increase in the humidity reduces the human comfort , the chances of bacteria, viruses have been increased sandal so this condition is not suitable to asthmas patient. So we modified an Air Cooler, which will not increase the percentage of humidity in the air. The aim of this project is to develop an Air Cooler which will not increase the humidity of the air as in case of conventional Air Cooler. Air Cooler ia an appliance that keeps the atmosphere cold. The basic concept is to make the indirect contact of water and sir which goes out of the cooler as compared to Air conditioning system which can be used in house and office.

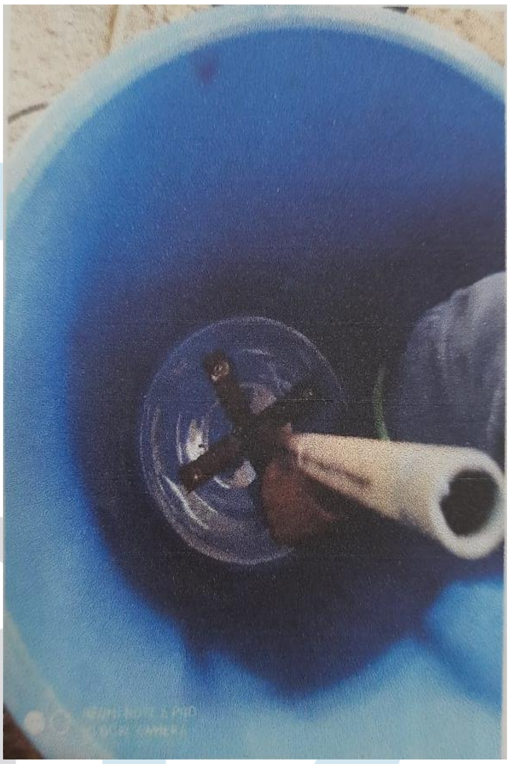
Vignesh Ravi, A. Sathishkumar: Design and Fabrication of Mini Air Cooler

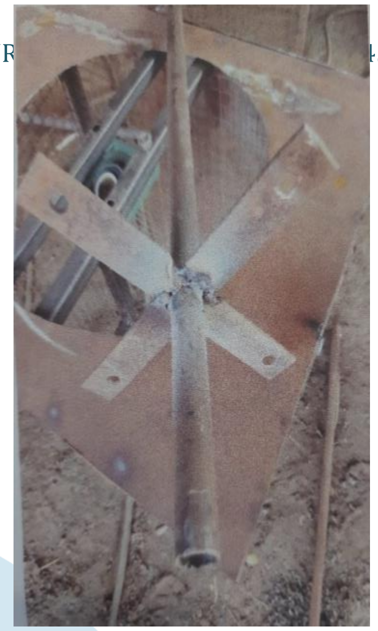
The air conditioner and air cooler are widely used in the world. These electrical devices consumed more electricity power and it is not benefit for the poor people. In practice power shortage is also occurred. These problems are rectified by modification of ordinary table fan. In summer season, the ordinary table fan gives small amount of cold air in the room. So the table fan is modified by using copper tube with fins and special design Cooling Chamber. In this project the cooling of air by using cold water or any other refrigerant which is circulated in the copper tube foe the purpose of reducing the heat in the surrounding environment, where it is of great importance in widely distributed villages with little or no rural electrification and also in the urban areas where power shortage is often in practice.

Srinivasa, H. S. Lohit: Design and Development of a Low Cost Air Cooler

Air Cooler is one of the appliances that keeping the atmosphere cold. The basic concept of water cooling is to find a medium that can handle and transport heat more efficiently than air. Water has a very good ability to retain heat, in the meantime stay in a liquid form. This project is to design and develop a low cost air cooler which can be used in houses and offices secondary researches have been carried out to collect data regarding the present design of air cooler. Various types of air cooler are available in the market have been identified Ethnographic study and questionnaire survey has been done for understanding the user product interface. The issues related to current air cooler have been found out. QFD and PDS are prepared based on the data collected. Concepts are generated according to the PDS prepared. Concepts of an air cooler with additional of a separate fan to spread the water in to the air for cooling. Air cooler with a separate fan is selected as the final concept through weighted ranking methods. Colours are chosen according to its applications to make it aesthetically good. A working model of the final concept is made using wood.

PHOTOS OF SETUP





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EVALUATION OF SOIL NUTRIENTS BY USING TYPE-1 FUZZY SET

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Abstract:

To study the status and quantity of available soil nutrients in soil study was conducted in typical farm of Miraj, Sangli district in Maharashtra sample from each farm were collected and scientifically analysed. The subjective information is quantified by using fuzzy sets. The problem of selection of soil containing "high" availability of Nitrogen (N), Phosphate (P) and "medium" Potassium (K) is demonstrated as application of type-1 fuzzy set.

Key Words: *Type-1 Fuzzy Set.*

Introduction:

In determining the relation, availability of nutrients in the soils, the chemical properties of soil play vital role. The literature evident that the soil of Maharashtra are clayey in texture, neutral of alkaline in reaction, low to medium in organic carbon and non-calcareous to calcareous in nature [Gajbe etal. 1976] and Malewar [1994]. Deficiency of these nutrients in spreading in soil at faster rate due to intensive cropping, imbalance fertiliser use and lack of efficient management. Therefore, it is the need of hour to maintain soil health for sustainable, productivity, food security and increasing agricultural production in order to meet the increasing demand against limited soil resource base. Therefore the study of chemical properties of soils like soil containing Nitrogen (N), Phosphate (P) and Potassium (K) and monitoring frequently these properties important. On that respective information it will beneficial to improve quality of soil and also improve production of crops.

Phosphorus:-Phosphorus is a component of the complex nucleic acid structure of plants, which regulates protein synthesis. Phosphorus is, therefore, important in cell division and development of new tissue. Phosphorus is also associated with complex energy transformations in the plant.

Nitrogen:-Nitrogen is one of the macronutrients which is required in large amount for plant metabolism and growth act as a primary nutrient for plants. It is absorbed in Ammonium (NH_4^+), Nitrate (NO_3^-) ions forms. Nitrogen is the element which is not directly available to plants from atmosphere and earth's crust.

Potassium:-Normal plant growth requires large quantities of potassium. In fact, throughout growth most crops contain more potassium than any other nutrient including nitrogen (N). Small quantities of potassium are needed to support many of the crucial enzyme processes within the plant whilst much larger amounts are used to control the water relationships in the plant. Potassium also plays a vital role in the transport of sugars and other products of photosynthesis from leaves to storage organs.

Preliminaries:

Let X be any universe of discourse which is never fuzzy. Type-1 fuzzy set is mapping to the interval 0, 1. Which depends on the vague concept A of a linguistic variable [Zadeh, 1965]. The function A is usually called the membership function of the fuzzy set A. To each element $x \in X$ is adjoined an element $A(x) \in [0,1]$called the membership grade of X in the fuzzy set A .

$$A(x)=\begin{cases}1 & \text{if } x\in A\\ 0 & \text{if } x\notin A\end{cases}$$

And $A(x) \neq [0,1]$if $x$partly belongs to A . If the real interval [0,1] is allowed to the valuation set$\{0,1\}$, A becomes a characteristic function on X to$\{0,1\}$. In this sense fuzzy set is generalization of a classical subject of a set.

Operations on fuzzy sets

Let U be domain and A, B be fuzzy sets on U .

Union of A and B , denoted by $A \cup B$, is a defined as that fuzzy set on U for which $(A \cup B)(x)= \max(A(x), B(x))$for every $x$in$U$.

Intersection of A and B , denoted by $A \cap$, is a defined as that fuzzy set on U for which $(A \cap B)(x)= \min(A(x), B(x))$for every $x$in$U$.

The set$\{x \in U / A(x)> 0\}$is called the *support* of A and is denoted by supp (A).

The height of A is defined to be that number ht (A),

i) $A(x)\leq ht(A)$for all supp(A)for all $x$in supp (A)

ii) $A(x)= ht(A)$For at least one supp(A).

(A) Is said to be normal if $A(x)= 1$ for at least one $x$in$U$. The set $\{x \in U / A(x)= 1\}$is called the *core* of the fuzzy set (A). Normal fuzzy set on R whose support is bounded and whose α -cuts are closed intervals for all α in (0,1]

$A=\{a1,a2,.....an\}$Is the set of alternatives and $C=\{c1,c2,.....cn\}$is the set of criteria. Let

$w1,w2,......\ wn$ be set of weights indicating the important of the criteria. Let $w=\sum wi$be the sum of weight. Then Type-1 fuzzy relation is given by

$\boldsymbol{R = [rij\ ]}$**On** $\boldsymbol{C \times A}$**.**

For each alternative $aij(j=1,2,3,......,n)$we determine m number of fuzzy sets $S(i, j)$ $S(i, j)= \min(rij\ ,\ wj\ ) i = 1 \text{to}\ m$. We use Max-Min or Max-Product composition of W and R to obtain the decision of fuzzy set D , where $D = R \circ W$

Defuzzification. We take that alternatives $a$in supp D as the best one for which $D(a)= ht\ (D\ )$

Model for nutrient Assessment in soil samples:

$S=\{s1,s2,.....sn\}$Is the set representing soil samples specified farming system and $C=\{c1,c2,.....cn\}$is the set of criteria used for assessing soil sample. Let $w1,w2,......\ wn$ be the set of weights indicating the importance of criteria.

Let $w=\sum wi$ be the sum of weight. Then Type-1 fuzzy relation is given by $R = [rij]$on $C \times S$.

For each alternative $sj(j=1,2,3,......,n)$we determine $m$number of fuzzy sets $S(i, j)$ $S(i, j)= \min(rij\ ,\ wj\ ) i = 1\text{to}\ m$

Materials and Methods:

Total 50 samples were collected from 10 different farms of the single typical village in Miraj tehsil during 2021-22. These samples were analysed in the soil analysis lab for their chemical properties as per standard methods see (Jackson 1978). Nitrogen was estimated by alkaline permanganate methods see (Subbjah and Asija, 1956). Potassium was determined with neutral normal ammonium acetate and the potassium in the extract was determined by using flame photometer (Jackson 1973).

Formulation of fuzzy sets

$$\text{‘Medium” content of } K,\ K(x)=\begin{cases}0 & x \le 300\\ \dfrac{x-300}{400} & 300 < x < 700\\ 1 & x \ge 700\end{cases}$$

$$\text{“High” content of } P,\ P(x)=\begin{cases}0 & x < 6\\ \dfrac{x-6}{11} & 6 \le x \le 17\\ 1 & x > 17\end{cases}$$

$$\text{“High” content of } N,\ N(x)=\begin{cases}0 & x < 120\\ \dfrac{x-120}{230} & 120 \le x \le 350\\ 1 & x > 350\end{cases}$$

Table 1

Characteristic of fuzzy values

Soil Sample / Criteria	s_1	s_2	s_3	s_4	s_5	s_6	s_7	s_8	s_9	s_{10}	W_s
NC_1	0.263	0.273	0.209	0.209	0.229	0.089	0.292	0.667	0.976	0.746	0.4
PC_2	0.309	0.064	0.100	0.300	0.382	0.527	0.864	0.955	0.955	0.945	0.4
KC_{31}	0.817	0.556	0.584	0.691	0.412	0.597	0.625	0.453	0.063	0.975	0.2

"High" Nitrogen content of (N)

$$= \frac{0.263}{s_1} + \frac{0.273}{s_2} + \frac{0.209}{s_3} + \frac{0.209}{s_4} + \frac{0.229}{s_5} + \frac{0.089}{s_6} + \frac{0.292}{s_7} + \frac{0.667}{s_8} + \frac{0.976}{s_9} + \frac{0.746}{s_{10}}$$

"High" Phosphate content of (P)

$$= \frac{0.309}{s_1} + \frac{0.064}{s_2} + \frac{0.100}{s_3} + \frac{0.300}{s_4} + \frac{0.382}{s_5} + \frac{0.527}{s_6} + \frac{0.864}{s_7} + \frac{0.955}{s_8} + \frac{0.955}{s_9} + \frac{0.945}{s_{10}}$$

'Medium" Potassium content of (K)

$$= \frac{0.817}{s_1} + \frac{0.556}{s_2} + \frac{0.584}{s_3} + \frac{0.691}{s_4} + \frac{0.412}{s_5} + \frac{0.597}{s_6} + \frac{0.625}{s_7} + \frac{0.453}{s_8} + \frac{0.063}{s_9} + \frac{0.975}{s_{10}}$$

Fuzzy weights (W) $W = \{0.4, 0.4, 0.2\}$

Decision fuzzy set (D)

$D(x) = (R \circ W)(x), R : C \times S \to [0,1]$

$D = \{0.309, 0.273, 0.209, 0.3, 0.382, 0.4, 0.292, 0.4, 0.4, 0.4\}$

One way of interpreting this is that, any one out of four soil samples $s6$, $s8$, $s9$ and $s10$ can be selected satisfying C 1 , $C2$ and $C3$. To signal out only one soil sample we look at the weights of the criteria and find that tie occurs at the row C 1 and $C2$ ignoring this two rows we form composition again to get $D = \{0.2, 0.2, 0.2, 0.2, 0.2, 0.2, 0.2, 0.2, 0.2, 0.2\}$ Again tie occurs. Either we break the tie arbitrary ignoring $C1$ to select soil sample out of $s6$, $s8$, $s9$, $s10$. Ignoring C 1 we get $D = \{0.309, 0.2, 0.2, 0.3, 0.382, 0.4, 0.4, 0.4, 0.4, 0.4\}$ Again we select $s6$, $s7$, $s8$, $s9$, $s10$and out of this either of sample is selected. Ignoring $C2$.

We get $D = \{0.263, 0.273, 0.209, 0.229, 0.229, 0.2, 0.292, 0.4, 0.4, 0.4\}$ $D(s6)$= 0.2,$D(s8,s9,s10)$= 0.4. Therefore soil samples $s8$, $s9$, $s10$are satisfying C 1, $C2$, $C3$ Therefore both these samples could be selected and sample $s6$ is ignored.

Study Area:

Sangli District is located in southern-western part of Maharashtra State having area 8522 Sq.km. geographical area which is situated between 16° 4′ to 17° 1′ North latitude and 73°43′ to 75° 00′ East longitude. This district consists of 11 Tahsils with total 723 villages. The district is divided into two major regions viz., Western area along Krishna river basin with abundant water supply and arid region includes drought prone zone along Eastern part. The arid region includes Kadegaon, Khanapur, Atpadi, Tasgaon, Jath, and Kavathe-Mahankal Tahsil and Eastern part of Miraj Tahsil. The average rain fall is about 620 mm per year due to South-West Monsoon. The average temperature of this area ranges from 13^{o}C to 45^{o}C.

Conclusion:

The available N and P were medium and high in respect of K. The soil sample $s8$, $s9$, $s10$ satisfying criteria. The average lowest N content was observed in soil sample $s6$, whereas, the highest N

content in soil sample $s9$. The average lowest P content observed in soil sample $s3$ and highest P content in soil sample $s8$. The average lowest K content was observed in soil sample $s9$, whereas, the highest K content in soil sample $s10$. Remaining soil sample need to improve the health texture based on recommendation of soil analysis report by expert.

Appendix

Characteristics of crisp values

Soil Sample / Criteria	s_1	s_2	s_3	s_4	s_5	s_6	s_7	s_8	s_9	s_{10}
N kg / ha	180.52	182.9	168.1	168.1	172.8	140.4	187.2	273.3	344.5	291.6
P kg / ha	9.4	6.7	7.1	9.3	10.2	11.8	15.5	16.5	15.3	16.4
K kg / ha	626.7	522.5	533.7	576.2	464.7	538.9	550	481	325	690

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CHARACTERIZATION OF A-DISTRIBUTIVE SEMILATTICES

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Abstract:

In this paper, we defined a-distributive semilattice and obtain properties of a-distributive semilattice in terms of a-ideals and â-filter. Also we have obtain several characterizations of a-distributive semilattice.

Key Words: *a-distributive semilattice , a-ideals , â-filter*

Introduction:

0-distributive lattice concept introduced by Varlet. Then P. Balasubramani and P. Venkatanarasimhan have obtain many characterizations with the help of ideal, filter , prime ideal , minimal prime ideal etc. A lattice L with 0 is called a 0-distributive lattice if for all a, b, c ∈ $\boldsymbol{L}$ with a ∧ b = 0 and a ∧ c = 0 imply a ∧ (b ∨ c) = 0. Any distributive lattice with 0 is 0 - distributive. In this paper we will study the a-distributive meet Semilattices. Y. S. Pawar and M. V. Patil introduced the concept a - distributive lattice for any fixed element a ≠ 1 in bounded lattice. Also defined a-ideal, prime a-ideal, minimal prime a-ideal and â-filter, etc. and obtain many characterization. Any a - distributive lattice is 0 – distributive. In this paper we generalized concept a-distributive lattices to a-distributive semi lattices. Also we introduced a-ideal, prima-ideal, minimal prime a-ideal and â-filter in a-distributive semi lattices.

Let S be a meet semilattice with 0. Let a, b, c in S be such that whenever $\mathbf{b \vee c}$ exists, $\boldsymbol{a} \wedge \mathbf{b} = \mathbf{0}$ and $\mathbf{a \wedge c = 0}$ imply $\mathbf{a \wedge (b \vee c) = 0}$, then S is called 0-distributive semilattice. We generalized a-distributive semi lattice as x, y, z, a (a ≠1) in S be such that whenever $\mathbf{y \vee z}$ exists, $\mathbf{x \wedge y \leq a}$ and $\mathbf{x \wedge z \leq a}$ imply $\mathbf{x \wedge (y \vee z) \leq a}$.

The Hasse figure given below is example of a-Distributive Semilattice.

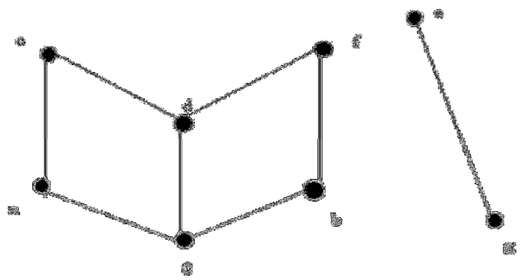

Fig. 1

The following figure shows that a-distributive semilattice need not be distributive.

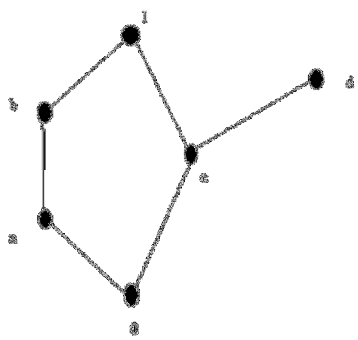

Fig. 2

The following figure is example of semilattice is not a- distributive.

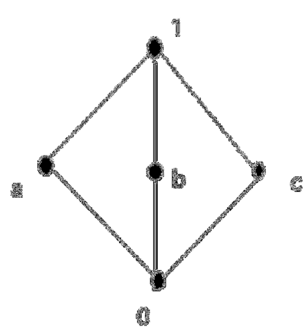

Fig. 3

An ideal I in S is a non-empty subset of S such that a ≤ b, b∈I implies a∈I and whenever avb exists for a, b in I then a v b∈I. (see Venkatanarasimhan [1]). A proper ideal I in S is called prime if x ∧ y ∈I implies that either x ∈ I or y ∈I.

Varlet [5] has generalized the concept of maximal filters and introduce a - maximal filter in L. Thus maximal â - filter in M is a filter in L which is maximal with respect to not containing the given fixed element a (≠ 1) in L . An â - filter is a filter in L not containing a . In this chapter we introduce the concepts of semi a - ideal , a - ideal , prime semi a - ideal and minimal prime a - ideal etc. in S. We begin with simple but essential concepts.

Definition and Properties:

Definition 2. 1: - A non-empty subset I of S is semi- ideal in L if x ≤ y , y ∈ I imply x ∈ I for x , y in S .

Definition 2.2: - A semi-ideal in S containing the element a is called semi a - ideal.

Definition 2. 3: - A prime semi-ideal in S containing the element a is called prime semi a - ideal.

Definition 2.4: - An ideal in S which is maximal w. r. t containing the element a is called maximal a - ideal.

Definition 2.5:- Minimal element in the set of all prime a - ideals in S is called minimal prime a - ideal.

Note that for a = 0 in particular, the above definitions 1 to 5 coincide with the usual definitions of semi-ideal , prime semi-ideal , maximal ideal , minimal prime ideal respectively (see Venkatanarasimhan [1]) .

We begin with a rather elementary result the easy proof of which is omitted.

While proving the properties of prime semi ideals , Venkatanarasimhan [1] has proved that , a nonempty subset F (F ≠ 1) of L is filter if only if (L \F) is prime semi - ideal .

More generally, we prove

Theorem 2.1: - A non - empty subset F of S (F ≠ 1) is â - filter if and only if (S \ F) is prime semi a - ideal .

Proof:- only if part .

let F be â - filter in S . As a ∉ F we get a ∈ (S\ F). Hence (S\ F) is non-empty . Let x ≤ y and y ∈ (S\ F). Suppose x ∉ (S\ F) we get x ∈ F. But as F is filter we get y ∈ F; a contradiction. Therefore x ∈ (S \ F) . Hence (S \ F) is semi a - ideal in S .

If x ∧ y ∈ (S \ F) then x ∧ y ∉ F . As F is filter , either x ∉ F or y ∉ F . Thus x ∈ (S \ F) or y ∈ (S \ F) . This shows (S \ F) is prime semi a - ideal.

If part.

Let (S \ F) be prime semi a - ideal in 1 . To prove that F is â - filter .

(i) As a ∈ (S \ F) we get a ∉ f and hence F is non-empty .

(ii) Let x ≤ y and x ∈ F .Suppose y ∉ F. Then we get y ∈ (S \ F). But as (S \ F) is semi ideal we get x ∈ (S \ F); a contradiction. Thus y ∈ F.

(iii) Let x , y ∈ f . Then x , y ∉ (S \ F) . As (S \ F) is prime semi ideal we get x ∧ y ∉ (S \ F) .i.e. x ∧ y ∈ F. From (i) , (ii) and (iii) we get F is filter in S . As a ∉ F we get F is â - filter.

Theorem 2.2:- Any â - filter in S is contained in some maximal â - filter .

Proof: - Let F be â - filter in S. Define Ḳ = { J | J is an â - filter in L containing F } . As F ∈ Ḳ we get Ḳ is non-empty. Let ξ be any chain in Ḳ and X = ∪ C ∈ξ C . Then obviously, X is filter in S as X is union of members of chain of filters in S. Further as F ⊆ X and a ∉ X.

We get X ∈ Ḳ. By Zorn's Lemma, there exists a maximal element M in Ḳ. This M is maximal â - filter containing F.

Theorem 2.3:- Let F be â - filter in S. Then F is maximal â - filter if and only if for x ∉ F there exists y ∈ F such that x ∧ y ≤ a.

Proof: - Only if Part.

Let F be maximal â – filter in S and x ∉ F.

Then $F \vee [x)$ is filter such that $F \subset F \vee [x)$. But as F is maximal â - filter we get $a \in F \vee [x)$. This implies $a \geq x \wedge y$ for some $y \in F$ and the result follows.

If Part.

Let F be any â - filter in S satisfying the condition in the statement. Now we prove F is maximal â - filter in S. Let if possible there exists â - filter J in L such that $F \subset J \subseteq S$. As $F \subset J$, there exists $x \in J$ such that $x \notin F$. By assumption, there exits $y \in F$ such that $x \wedge y \leq a$. Now $F \subset J$ and $y \in F$ imply $y \in J$. As $x \in J$, $y \in J$ we get $a \in J$; a contradiction. Hence F is maximal â - filter in S.

Characterizations:-

In the following theorem we characterize a - distributive lattices in terms of a - ideals in S.

Theorem 3. 1:- The following statements are equivalent in S.

1. S is a - distributive semi lttice.

2. If $x, y_1, y_2, \ldots, y_n$ in L such that $x \wedge y_i \leq a, \forall i, 1 \leq i \leq n$, then $x \wedge [y_1 \vee y_2 \vee \ldots \vee y_n] \leq a$ if $y_1 \vee y_2 \vee \ldots \vee y_n$ exists.

3. If A is a - ideal and $\{A_i \mid i \in I\}$ is a family of a - ideals such that $A \cap A_i \subseteq (a]$, for all $i, 1 \leq i \leq n$, then $A \cap [\vee_{i \in I} A_i] \subseteq (a]$.

Proof:-

(1) $\Rightarrow$ (2)

As S is a - distributive, the result is true for n = 2. Using the induction on n, the implication follows.

(2) $\Rightarrow$ (3) let a be a - ideal and $\{a_i \mid i \in i\}$ be a family of a - ideals such that

$A \cap A_i \subseteq (a]$, for all $i, 1 \leq i \leq n$. If $x \in a \cap [\vee_{i \in i} a_i]$, then $x \in a$ and $x \in \vee_{i \in i} A_i$. As $x \in \vee_{i \in i} A_i$ we get $x \leq y_1 \vee y_2 \vee \ldots \vee y_n$ for some finite n with $y_i \in a_i$ for all $i, 1 \leq i \leq n$ if $y_1 \vee y_2 \vee \ldots \vee y_n$ exits. As $x \in A$ and $y_i \in A_i$ we get $x \wedge y_i \in A \cap A_i \subseteq (a]$.

Therefore $x \wedge y_i \leq a$, for all $i, 1 \leq i \leq n$.

Hence by assumption (2), $x \wedge [y_1 \vee y_2 \vee \ldots \vee y_n] \leq a$.

Thus $x \leq a$. This shows $A \cap [\vee_{i \in I} A_i] \subseteq (a]$ and the implication follow.

(3) $\Rightarrow$ (1)

To prove that S is a - distributive. Let $x \wedge y \leq a$, $x \wedge z \leq a$ for x, y, z in S. But this turn imply $(x] \wedge (y] \subseteq (a]$ and $(x] \wedge (z] \subseteq (a]$. By assumption (3), we get $(x] \wedge ((y] \vee (z]) \subseteq (a]$. Thus $x \wedge (y \vee z) \leq a$ as $(x] \wedge ((y] \vee (z]) = (x \wedge (y \vee z)]$.

Hence S is a - distributive lattice.

Thus (1) $\Rightarrow$ (2) $\Rightarrow$ (3) $\Rightarrow$ (1) shows that all the statements are equivalent .

Theorem 3. 2:- S is a - distributive if and only if every maximal â - filter is prime.

Proof: - Only if Part .

Let S be a - distributive semilattice and M be any maximal â - filter .

To prove M is prime . Let if possible there exist x , y in L such that $x \vee y \in M$ with $x \notin M$ and $y \notin M$. As M is maximal â - filter, $a \in M \vee [x)$ and $a \in M \vee [y)$. Then $a \geq m_1 \wedge x$ and $a \geq m_2 \wedge y$ for some $m_1, m_2 \in M$. But then $a \geq m_1 \wedge m_2 \wedge x$ and $a \geq m_1 \wedge m_2 \wedge y$ will imply $a \geq (m_1 \wedge m_2) \wedge (x \vee y)$ by a-distributive of S . But as $m_1 \wedge m_2 \in M$ and $x \vee y \in M$ we get $a \in M$; a contradiction. Thus $x \vee y \in M$ must imply $x \in M$ or $y \in M$. This proves that M is prime.

If Part.

Assume that every maximal â - filter in S is prime. To prove that S is

a - distributive semi lattice. Let if possible there exist x , y , z in S such that $x \wedge y \leq a$, $x \wedge z \leq a$ with $x \wedge (y \vee z) \nleq a$. Define $F = [x \wedge (y \vee z))$. Obviously, F is â - filter in S . By Theorem 1.2.7, F is contained in some maximal â - filter say M .But then $x \wedge (y \vee z) \in M$ imply $x \in M$ and $y \vee z \in M$ .M being prime , we get $x \wedge y \in M$ or $x \wedge z \in M$.

But in either the case $a \in M$; a contradiction. Hence $x \wedge y \leq a$, $x \wedge z \leq a$ imply $x \wedge (y \vee z) \leq a$ for x , y , z in S . Hence L is a - distributive lattice.

□□□

A lattice L is distributive if and only if for $x < y$ in L there exists a prime filter F containing x but not y . (see Gratzer [2] , page 78) . In the following theorem we prove a similar characterization for a - distributive semi lattice.

Theorem 3. .3:- L is a - distributive if and only if for $x \nleq a$ in L , there exists prime â - filter containing x .

Proof:- Only if Part .

Let L be a - distributive lattice and $x \nleq a$ for some x in S. As [x) is â - filter . By Theorem 1.2.7, [x) is contained in maximal â - filter say M. S being a - distributive, M is prime â - filter. This shows the existence of prime â - filter M containing x.

If Part .

Suppose L is not a - distributive. Hence there exist x , y , z in L such that $x \wedge y \leq a$, $x \wedge z \leq a$ with $x \wedge (y \vee z) \nleq a$. By hypothesis, there exits prime â - filter P containing $x \wedge (y \vee z)$. Then we get $x \wedge y \in P$ or $x \wedge z \in P$; P being prime â - filter . But in either the case $a \in P$, contradicting the choice of P.

Thus $x \wedge y \leq a$, $x \wedge z \leq a$ must imply $x \wedge (y \vee z) \leq a$ for all x , y , z in L . Hence S is a – distributive semi lattice.

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