Development of
Improved Lanterns
for Rural Areas

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I. The Problem

Around 60% of the rural households in India (60 million) use only hurricane kerosene lanterns for lighting. With unreliable electricity supply, even the remaining 40% of the households use kerosene lighting occasionally. There are guesstimates that close to 100 million such lanterns exist in the country.

The quality of light from the hurricane lantern is abysmal. It produces light from the glow of a yellow flame, which is equivalent to few candles and about one-tenth of that from a 60 W light bulb. There is another type of lantern called "Petromax" used in the country. This is a pressurized lantern where the incandescence of a rare earth mantle produces the light. Table 1 gives the comparison of these lighting devices.

It is therefore evident that there is a need to develop a lantern which is very efficient, safe, convenient to use, cheap and which gives light equivalent to that from a 100 W bulb. Besides, the new lantern should also run on alternative fuels like ethanol, which can be a renewable replacement for kerosene as a lighting fuel.

II. The Solution

A new efficient lantern running either on kerosene or diesel or with slight modifications on ethanol has been developed and tested. It has been christened "Noorie" and is shown below.

In designing and developing this lantern, the main considerations were:

1. The fuel consumption should be lower than that in the existing Petromax lantern.
2. It should produce light equivalent to that from a 100 W light bulb and that its efficiency should be higher than that of Petromax.
3. It should be very easy to light. In the existing Petromax lantern, the lighting arrangement requires alcohol fuel. Since most consumers do not have access to alcohol, they light the lantern by heating the fuel tube by rags dipped in kerosene which makes the glass chimney extremely dirty thereby reducing the light output considerably. This also necessitates frequent removal of glass chimney for cleaning, which leads to more frequent damage to mantle.
4. It should give an indication to the user when to start pressurizing the lantern. In Petromax lantern there is no way of knowing when the fuel tube is heated up. Thus many a times the lantern is pressurized prematurely, which results in liquid kerosene jet coming out of nozzle. This excess kerosene produces extremely sooty flame thereby making the mantle black and sooty and glass chimney dirty.
5. It should run on low tank pressures [of the order of 0.3-0.5 kg/cm2 (g)]. Existing Petromax lanterns run on 1.5-2 kg/cm2 (g) pressures, thereby increasing the hazard of fuel tank bursting. Because of high pressure, Petromax is also very noisy.
6. It should have a self-cleaning mechanism of the nozzle. In the Petromax lantern, the cleaning of nozzle is by a fine pin supported by an elaborate cam mechanism. This cam mechanism increases the cost of the lantern and provides a place from where the high-pressure kerogas can leak.
7. It should be easily affordable and very convenient to use. It should also be small and light in weight and should be able to run on renewable fuels like ethanol.

Noorie lantern with cooking arrangement

All the above problems were solved by designing a completely new (patented) "Noorie" lantern. The main components of the design were:

a) Proper air-fuel mixing arrangement and the use of air preheater which doubled up as silencer thereby making "Noorie" very silent.
b) Ability for self-cleaning of the nozzle.
c) Optimum fuel tube sizing for better heat transfer.
d) Extremely simple and convenient initial lighting arrangement.
e) Use of lightweight and sturdy materials of construction.

III. Test Results

1. ***Light output***: Light output measurements on Noorie kerosene and alcohol lanterns were conducted with the help of a standard Luxmeter and a Brodhum Photometer. All the photometric measurements were carried out relative to a calibrated 100 W light bulb. The results of these tests are shown in Table 2.
2. ***Cooking tests***: Noorie lantern also doubles up as a cooking stove. By removing the top cover and placing a utensil over the chimney, cooking is effected by flue gases. The heat of flue gases is completely wasted in Petromax lanterns. Tests conducted show that 0.4 liters of water in a covered pot is boiled in 25 minutes. Also 100 g of rice and 100 g of dal can be cooked easily in 25 and 60 minutes respectively.
3. ***Size of Noorie lanterns***: The Noorie kerosene lantern is 35 cm tall and weighs 1.6 kg while Noorie alcohol lantern is 33 cm tall and weighs 1.5 kg. In comparison, the Petromax is 40 cm tall and weighs 2.1 kg. The tank in Noorie lantern holds 700 g kerosene, which lasts for three to four days at 4-hours/day use.
4. ***Overall lighting efficacy***: Comparison of overall efficacy of a light bulb and that of kerosene/alcohol mantle light reveals interesting results. The overall power plant-to-light efficacy of a vacuum electric light bulb (100 W) is 3.21 lm/W. This includes power plant efficiency of 30%, power transmission efficiency of 80% and lamp efficacy of 13.4 lm/W. The existing Noorie kerosene and alcohol lanterns have efficacies of 2.03 and 2.82 lm/W respectively. With better thermoluminescent materials, the liquid fuel lamps can have efficacies surpassing those of the electric bulbs. Hence, efficiencies of liquid fuel lighting will be at par or even exceed those of electric lighting.
5. ***Cost of Noorie lantern***: Costing analysis reveals that Noorie lantern will cost about Rs. 350 in mass production.

NARI is ready to license this technology. Interested parties should contact:

Table 1: Comparison of Existing Kerosene Lanterns

Item	Lantern	
	Hurricane	**Petromax**
Initial cost (Rs.)	100-150	350-500
Light output lumens (lm)	65-70 (Equivalent to few candles)	1250-1300 (Equivalent to 100 W light bulb)
Advantages	Cheap; simple to light; handy; portable; can withstand 40 km/h wind	Good light output; portable; sturdy construction
Disadvantages	Very poor light output; problems of charring of wick and necessity of trimming and cleaning it; frequent glass breakage; poor construction.	Costly; heavy and tall; frequent breaking of mantles because of poor construction; difficult to light and requires alcohol to initiate lighting; tank pressure of 1.5-2 kg/cm^2 (g) and hence prone to tank bursting; very noisy; frequent cleaning of nozzle required thereby increasing inconvenience; frequent pumping (almost every fifteen minutes) required.

Table 2:

Light source (fuel)	Light output lumens (lm)	Fuel consumption	Efficacy (lm/W)	Initial cost (Rs.)
100 W bulb (electricity)	1340	100 W	13.4	400 (includes fitting & electrical connection)
Noorie (kerosine / diesel)	1300-1350	50-55 g/hr	2.03	350
Noorie (alcohol)	1270	65 g/hr of 93% (v/v)	2.82	350
Hurricane (kerosene)	68	16 g/hr (193 W)	0.35	100-150
Petromax (kerosene)	1300	80-90 g/hr (1025 W)	1.27	350-500
Fluorescent tube, 40 W (electricity)	2400	40 W	60.00	650 (includes fitting & electrical connection)

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