

A Polyethylene Dome for Biogas Plants

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The majority of domestic biogas plants in the world are fixed dome models, the construction of which requires skilled labour and suitable quality materials. In rural India and many other parts of the world these requirements are often difficult to meet and as a result the quality of build suffers. To combat this problem a gas dome has been manufactured from Polyethylene that gives a 100% gas tightness as well as offering considerable time savings during construction and the ability to retrofit onto failed systems.

What is a PE Dome?

The majority of domestic biogas plants in the world are fixed dome models with the dome section often needing skilled labour for construction. The quality of building materials plays a key role in the dome's gas tightness as any micro hole/crack will allow the gas to escape. In rural India and many other parts of the world the availability of affordable, suitable quality kiln fired bricks and raw materials is low and as a result build quality can suffer.

In evaluations of Indian biogas plants it has been found that the failure rate due to cracked/leaking domes is between 30-40%.

The PE Dome is a readymade 'off the shelf' plastic dome for the top of a domestic biogas plant and designed for use with the Indian Deenbandhu fixed dome type of two cubic metres capacity. The unit can be manufactured at any factory equipped with both plastic rotomoulding technology and a suitable mould, and then shipped to site for simple installation on the top

of the digester wall. The dome is made from Polyethylene (PE) with the resins blended to give good material strength, thermal properties etc. To date, three biogas digesters have been built with PE Domes and one defunct plant has been rehabilitated. After evaluating the performance of the four plants the Indian Ministry of New and Renewable Energy has approved it's dissemination under the National Programme for Biogas Development.

The advantages of a PE Dome

The PE Dome offers numerous benefits such as:

Pre-tested	Unlike the concrete or brick version, the PE Dome can be pre-tested for 100% gas tightness
Time saving	It takes a single day for the PE Dome to be installed, compared to a minimum of four days (including inside plastering) for the Deenbandhu biogas plant's dome. There is also no time delay in waiting for brickwork or concrete to cure, saving a further 7 days. The whole construction process can take 6 days, substantially less than the three weeks of a conventional plant [1]
Simple	The PE Dome installation needs no specialised skill, other than those required to build the rest of the simple biogas plant. The technology allows for easy transfer to grass roots level organisations
Retrofit	The PE Dome can be used to renovate existing biogas plants with faulty domes



Figure 1. Digester wall construction (Photo: CV Krishna)



Figure 2. Finished Biogas plant with PE Dome (Photo: CV Krishna)

Design Features

The dimensions of the PE Dome are essentially the same as for the conventional 2 cubic metre Deenbandhu Model plant:

Gas Volume	2 m ³
Thickness	5 mm
Collar Width	50 mm
Weight	40 kg
Height	730 mm (Dome apex to centre chord)
Radius of Curvature	1275 mm
Internal Chord Length	2340 mm (identical to Deenbandhu model at the point where the initial slurry level is fixed and so assures 100% gas tightness)
Material properties	Polyethylene (PE) with resins blended to give material properties suitable for i) 100% gas tightness, ii) resisting buckling and impact loads, iii) a suitable heat deflection temperature and iv) a good resistance to UV degradation
Transportation	The shape of the PE Domes allows for approximately 28 units to be transported on a typical Indian truck
Cost	Varies according to local rates, production volumes and transportation costs. The marginally higher cost of the PE Dome will be offset in the long run by no leakage/failure of the dome

The installation of a PE Dome

The biogas plant is constructed as per the Deenbandhu model; with the digester inlet tank and inner tank being constructed of brick and concrete (Figure 1). To fit the PE Dome the following steps are undertaken:

1. Holes are drilled for the apex gas pipe and collar bolts
2. Bolts are then inserted in to the drilled collar holes and the dome is placed up on bricks (5-7 around the circumference, 75mm high) before alignment with the digester wall. The bolts are placed head down with a piece of steel welded to the head to assure anchorage
3. The gap between the dome and digester wall is then filled with concrete (1:2:4 with medium sized gravel), ensuring that the bolts/steel pieces are firmly embedded. The bolts are then tightened
4. Fresh slurry can be loaded while the concrete is cured
5. The dome is then covered with alternate layers of rammed sand and clay (Figure 2)



Figure 3. Biogas plant during construction (Photo: CV Krishna)

Notes and References

¹For a comparative estimation of the conventional Deenbandhu and PE Dome biogas plants see www.hedon.info/APolyethyleneDomeForBiogasPlants

Profile of the author

Mr C.V. Krishna is the Executive Director of the CREAT (Centre for Renewable Energy and Appropriate Technologies) in Bhubaneswar, India. He is both a Mechanical and Civil Engineer and has been working in the field of renewable energy and appropriate technologies for the last 26 years.

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