Technology Development of Efficient Biogas Gensets (1-2 kW)

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Background

This document provides a summary of the work done at IISc, Bangalore on small, efficient SI engines running on biogas for stationary power generation in the range 1-2 kW. To give a background for this work, most of the efforts at the national level have typically focused towards conversion of diesel gensets to run on biogas in the single or dual-fuel mode resulting in large engines with poor efficiency values. Also, there is no efficient genset available in the 1 kW range. Most petrol-start, kerosene-run gensets converted to biogas operation have *overall* efficiencies (chemical to electrical) lower than 7%. This has been verified with systematic experiments conducted at IISc. At the international level, there are commercially available gas engines which run on biogas, however, these are typically very large engines generating several hundreds of kilowatts.

Prototype Development

Based on the work done as part of an MNRE project, significant knowledge has been generated towards development of a prototype biogas genset. The results of overall efficiencies obtained on a test bed with a 100-cc engine are shown in Figure 1. As observed from the Figure, a peak *overall* efficiency of 22% (this corresponds to an engine brake efficiency of 30%) at maximum load is obtained with the manifold injection strategy, and 18% with the conventional premixing strategy. As mentioned earlier, these efficiencies are much higher then what can be obtained with conventional petrol-start, kerosene-run genset modified to run on biogas.

Figure 2 shows a picture of the test rig, and Fig. 3 shows the manifold injection strategy. Figure 4 shows a laboratory level prototype being developed based on the premixed mode of fueling. This prototype is designated as Version-1. This version, which is based on this knowhow generated thus far, will have a gas carburettor, electronic governor, and a fixed optimal spark timing. This version when sent for

field trials is expected to deliver peak load *overall* efficiencies around 16%. As shown in Figure 1, the gas injection strategy incorporated by us is proven to yield higher efficiencies. However, in order to develop prototypes based on this concept, significant hardware development in terms of gas injector, ECU and low pressure pump is required. Also, a novel, direct mixture injection-based two-stroke engine (single cylinder, 50-70 cc) for two-wheeler applications has been successfully developed at IISc. There is enormous potential to adapt this engine for biogas operation with some modifications. It is hoped to initiate work soon with support from MNRE on these advanced concepts involving gas injection (designated as Version-2) and direct mixture injection-based two-stroke engine adapted for biogas operation (designated as Version-3). These engine concepts are expected to yield higher overall efficiencies.

Industry participation is welcomed at each of the following stages:

1. Commercialization of Version-1 prototype
2. Joint research, prototype development and commercialization of Version-2 concept
3. R&D and commercialization of Version-3 prototype

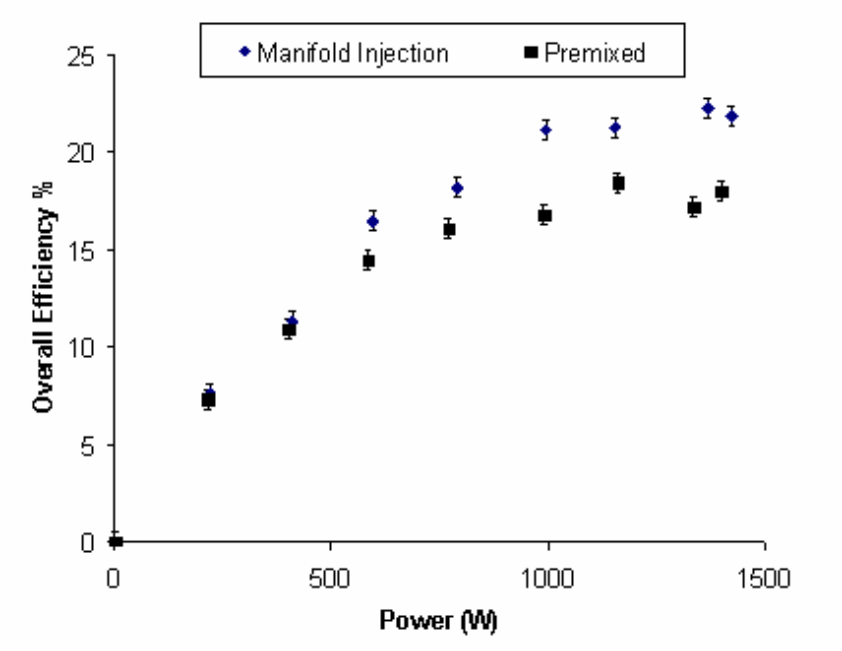

Figure 1. Comparison of overall efficiencies (chemical to electrical) with manifold injection and premixed mode of operation of a 100-cc single cylinder engine running on biogas

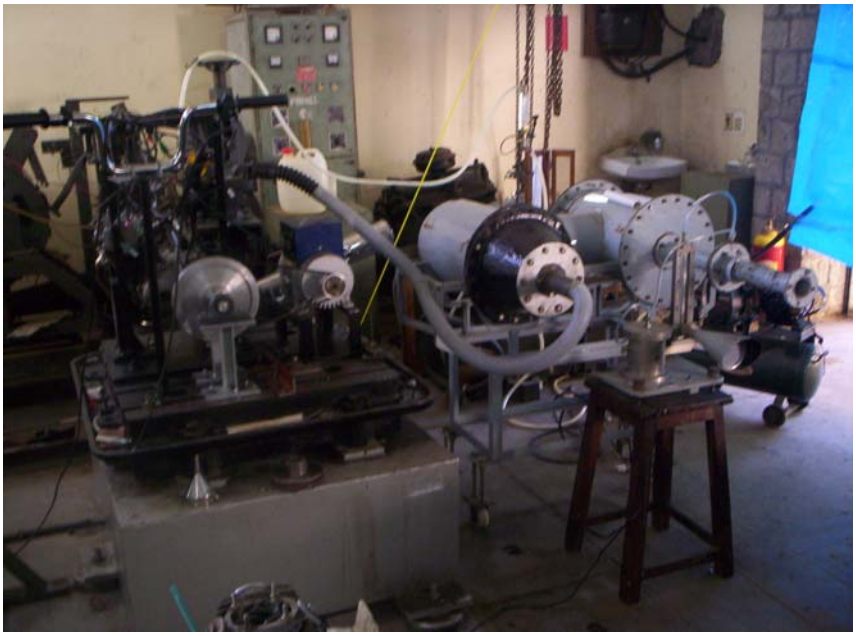

Figure 2. Picture of the experimental setup used in conducting the engine experiments with biogas. The airflow and fuel flow measurement rigs are also shown.

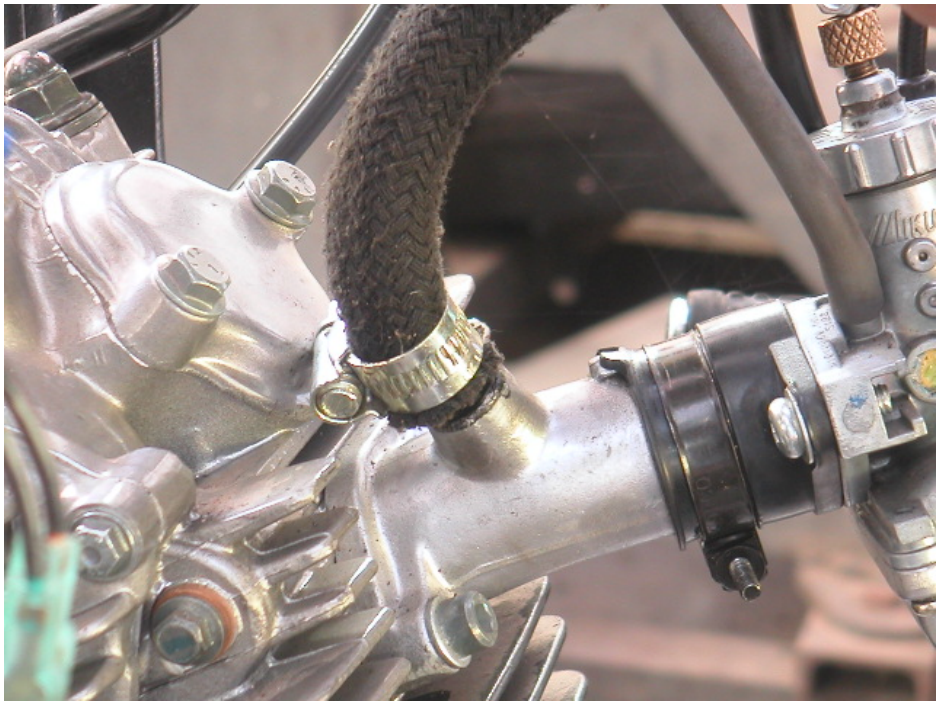

Figure 3. Manifold Gas Injection in the single cylinder 100-cc engine

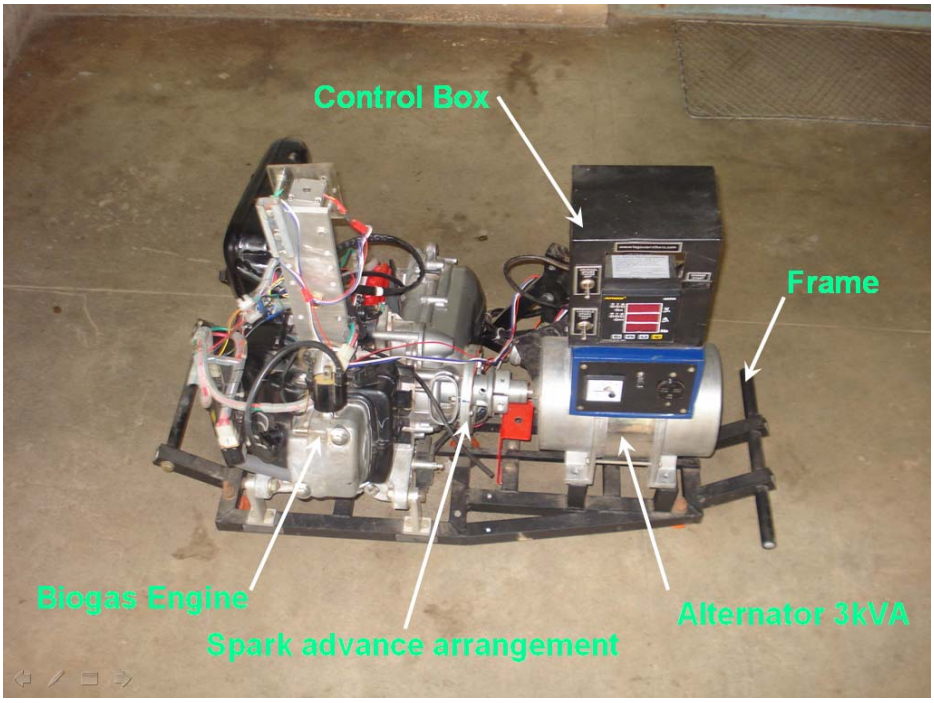

Figure 4. Laboratory Prototype of the Biogas genset (Version-1) showing the engine coupled to the alternator along with the control box, electronic governor and spark advance arrangement.