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Operational reliability of vegetable oil fuelled central heating plants

CHPs fuelled by vegetable oil have important environmental benefits. Obstacles to further development, however, include uncertainly regarding their reliability. Three selected rape oil fuelled CHPs were thus tested in operation. Typical vegetable oil weaknesses were shown affecting above all the fuel conveyance and injection systems. However, characteristic operational difficulties could to a large extent be avoided by using specific qualities of vegetable oil and consideration of the special demands this fuel makes on the plant components.

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Literature

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Central heating plants are characterised by efficient energy transformation and linked production of warmth and power. If special engines designed for running on vegetable oil are used (*fig. 1*), other environmental advantages are produced such as saving on resources and reduced CO_2 emissions. Additionally, vegetable fuel is rapidly biologically degradable and scarcely environmentally polluting. Thus its application is especially suitable in environmentally sensitive areas such as the Alpine region. Further important application areas for vegetable oil fuelled CHPs are rural locations where the regional production and utilisation of vegetable oil and resultant cake allows, through low transport inputs, the achievement of a high exploitation of rape oil energy content and gives a positive impulse to rural structural development. Through encouragement of electricity power supply in the context of the regenerative energy law, the reduction in availability of mineral oil and the strengthening of public environmental awareness, vegetable oil fuelled CHPs in the lower output classification are increasingly in demand.

Practical experiences with vegetable oil fuelled CHPs have been very different up until now. Alongside engines with long-term reliability other plants have experienced repeated cases of serious difficulties so that these have had to stop production after a short time without the precise reasons being able to be analysed. Thus many weak points could not be identified and technical problems were unable to be avoided even with new plants, in that the experiences up until then were not processed and made available for designers and operators. Thus the aim of a research project of the Bavarian State Institute for Environmental Protection (BayLfU) and the Bavarian State Ministry for Rural Development and Environmental Matters (BayStMLU) was to investigate the performance of selected CHPs in practical operation, identify eventual technical problems and offer solutions for the avoiding of breakdowns [2].

Methods

For this, three rape oil fuelled CHPs of different production capacities (8 kW_{el}, 60 kW_{el}, 110 kW_{el}) were investigated during a 30-month field trial in different Bavarian locations. Alongside the documentation of the technology used, the quality of the fuel used during the observation period, important working characteristics (temperatures, pressures, volume flows), the problems arising and service and repairs were noted.

Results

The designs of the CHPs were fundamentally different. Definite differences included not only the engines used, but also the fuel delivery systems (*table 1*). The vegetable oil properties varied according to storage and production conditions as well as with impurities introduced during transport. Especially strongly variable were the fuel characteristics total impurities, oxidation stability and neutralisation number, often not remaining within the required limitations of the „RK-quality standard 05/2000“ [1] (*table 2*).

Table 1: Technical features of the investigated CHP-units

Technical features		CHP 1	CHP 2	CHP 3
Electricity output	kW_{ei}	110	60	8
Thermal output	kW_{th}	110	90	15
Operating since		05/1996	06/1997	03/1999
Working hours at 14. 12. 00	h	3290	10277	5165
Burning system		Direct injection	Direct injection	Mixing chamber
Capacity	l	11,8	5,9	1,7
Cylinders		6	4	3
Heat exchanger		Turbo cooler	Generator	Generator
		Engine	Engine	Motor
		Exhaust	Exhaust	Exhaust
Fuel pre-heating		In delivery piping	In daytank	None
Fuel pump		Electric	Mechanical	Electric
Fuel piping		NBR piping	Copper piping	Steel piping

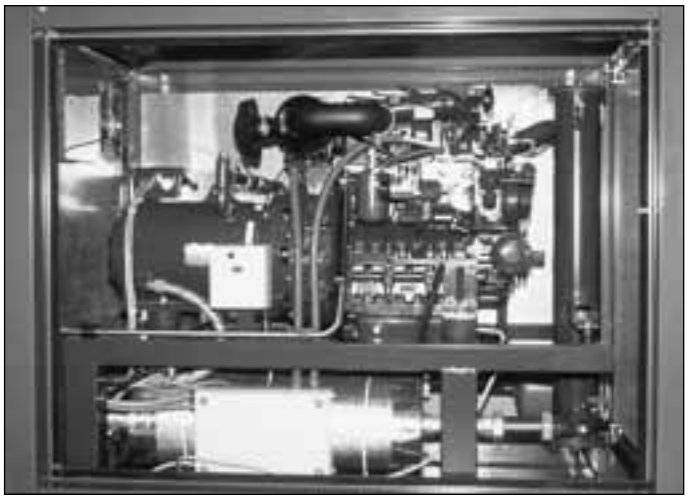

Bild 1: Pflanzenölbetriebenes BHKW-Aggregat

Fig. 1: Vegetable oil fuelled CHP-unit

High solids content or foreign material in the vegetable oil led increasingly to breakdowns through fuel starvation because of blocked filters, pipelines and pumps which then caused increased maintenance work (increased filter changes) or could also require a complete replacement of the fuel system. Through using „RK quality standard 05/2000“ rape oil with its minimum requirements for oil as fuel these kind of problems could be avoided to a large extent.

However, not only vegetable oil impurities could cause difficulties in fuel supply to the engines. Inappropriate dimensioning and positioning of the fuel pump could be responsible as could the using of pipeline materials which increase oil ageing (copper, brass) or pre-aged rape oil such as encouraged by the use of heated day tanks. On the other hand, cool and dark storage conditions can prevent rapid oxidation and polymerisation of the rape oil and help towards a reliable fuel supply.

In that vegetable oil causes, in general, large demands on the injection system through its high viscosity and tendency to resinification as well as the higher injection pressure which is mostly required, only high quality injection pumps and jets from proven manufacturers should be used. Additionally, vegetable oil with high oxidation stability, low neutralisation number and low water content prevents possible wear problems and material damage of the fuel transportation system.

Vegetable oil engines are often characterised through higher burning temperatures in the firing chamber. Therefore it's important to keep a special eye of efficient engine cooling to thus avoid engine damage through overheating. Appropriate engine ventilation, clean heat exchange surfaces and a sufficient amount of coolant (cooling water, engine oil) greatly help working reliability.

Just as with other engine-powered CHPs, the vegetable oil fuelled ones require a certain amount of input in inspection and servicing. Expert, experienced and interested high quality service personnel are critical for their successful operation. Only in this way can signs of problems be identified early and countermeasures taken.

Conclusion

Reliable running of vegetable oil fuelled CHPs is therefore possible when the rape oil fuel meets specific quality criteria, when the appropriate CPH fuel conveyance components are used and where inspection and maintenance are carried out by expert personnel which identify themselves with the plant.

Table 2: Wichtige Eigenschaften der eingesetzten Rapsöle

Trail parameters	Unit	CHP 1	CHP 2	CHP 3	Limiting value (RK-standard)	
		Average	Average	Average	Min.	Max.
Density DIN EN ISO 3675	kg/m³	920	920	920	900	930
Iod number DIN 53 241-1	--	115	113	113	100	120
Total impurities DIN EN 12662	mg/kg	38	41	141		25
Oxidation stability (110°C) ISO 6886	h	5,9	0,4	7,3	5,0	
Neutralisation number DIN EN ISO 660	mg KOH/g	1,1	2,8	0,9		2,0

Literature

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