THE JENTZSCH-PRIMING-VALUE-TESTER, EXAMPLES OF USE

The use of the selfignition curve as an indication of the suitability of a liquid fuel for any special purpose. The article itself merely gives examples of performance, no correlation of any kind is made.

The Jentzsch-Priming-Value-Tester, Examples of use.

Combustion engines

1.ex. An aeroplane motor was objekted to by the buyer because strong premature ignitions made it impossible to set the motor going. The motor had successfully passed all the tests made in the testing shop of the works. The compression pressure was ascertained to be 4,5 at. An examination of the fuel showed that spontaneous ignition curve of the gasoline used by the buyer showed an extremely low lying and extensive premature ignition range. After a fuel had been obtained corresponding to the original self-ignition curve, the motor again worked perfektly.

2.ex. A heavy motor lorry was to be used for some time in a mountainous region. The mixture of petrol obtained in the place of origin did not even permit the lorry to be fully loaded even on level ground, so that a failure in hilly country was feared. The compression pressure was 4,5 at The self-ignition curve of the fuel was found to be extremely low lying and extensive in area. The addition of benzole enabled the selfignition curve for 4,5 at. to be found, and a corresponding mixture of petrol and benzole was made. With this mixture of petrol and benzole the car was then used in mountainous country, under the sXXXXX severest strain, without the slyghtest breakdown (no change of spark plug). The extra expense incurred by use of the more expensive benzole was compensated by the fact that the fuel nozzle hitherto used could be replaced by one 15 % smaller, ensuring a considerable saving in fuel. When the engine was examined some months later, all inner parts were found in exellen condition, there were no accumulations of soot.

3.ex. An old model of two cylinder Deutz petroleum motor, Bosch-Ignition, intended to drive a pumping plant, could not be made to run satisfactorily, in spite of beeing overhauled several times. As no data were obtainable with regard to the compression, the petroleum used as motor oil was reinforced with benzole, the charakteristic feature of petroleum motors (slight compression) beeing taken into account. The minimum priming value of the petroleum was therefore raised from 275/18 = 15,3 priming degree, to 280/32 = 8,3 p.d. and 280/42 = 6,7 p.d., enabling the premature ignition range to be raised

The experiments made with the reinforced fuels showed that the motor now started well and ran without trouble. The sole objektion noted was that when the mixture rich in benzole was used, the exhaust of one of the cylinders was unsatisfaktory, whilst the other exhaust (there were separate exhaust pipings) was invisible. When a mixture containing less benzole was used, the cylinder wich had previously given off vapour now worked perfektly smokelessly, whilst the exhaust of the other was slightly visible. The cause of this different working was found in the circumstance that the compression space of one cylinder was 4 mm higher than that of the other, and could therefore only supply the fuel mixture with slightly compressed oxygen. The fuel containing a high proportion of benzole encountred too little oxygen, and a part escaped unburnt with the exhaust gases. In the cylinder with greather compression, on the other hand, the exessive accumulation of oxygen led to the imperfekt combustion of the mixture containing a smaller proportion of benzole. The varying compressions of the two cylinders rendered it impossible to make both exhausts entirely invisible. The motor ran however perfektly steadily and without trouble, under full load, with the mixture containing less benzole, and consuming only a slight amaunt of fuel. After the compression spaces had been equalised, the motor ran perfektly.

4.ex. A small petroleum motor ,already set aside as useless for years,was made to run perfektly satisfactorily again by the use, in the same manner,of a reinforced petroleum.

Incandescent ignition motors.

5 ex. An incandescent ignition motor used for driving the screw of a fishing boat had to be run with gasoil obtained at a harbour into wich the boat was run,the supply of fuel carried being exhausted.The motor now began to run irregularly and a noticeably larger amount of fuel was consumed.

As no details were obtained on the compression and heat capacities of the motor,the empirical value of 500 degr.XXX(Cels) was assumed for the temperature of the incandescent head.After the selfignition curves had been registered,it was ascertained that the curve of the fuel wich had proved suitable required an approximate ignition pressure of 2,8 at.As compared with 1,6 at for the unsuitable fuel.The surplus of 1,2 at had to be compensated by an increased supply of fuel,wich was the explanation of the higher consumption.All other trouble arising proved to be equally due to be use of motor fuel unsuited to the motor.After the fuel formerly used had been obtained the motor ran perfektly again.

6.ex. An incandescent ignition motor used for purposes of instruction,compression 6,2 at.,ran satisfactorly with a mineral gasoil.The supply of this oil running out,the attempt was made to run the motor with another motor fuel.The motor only ran for a short time,and after coming to a standstill by itself,could not be induced to start again.When the cylinder cover was removed, an extremely thick accumulation of soot was found covering the inner XXX parts of the motor,and the valves were unable to work.

An examination of the selfignition curve of the new motor-fuel showed,that its selfignition at a temperature of 500 degr.C.required an ignition pressure of 6,5 at,whilst the gasoil previously employed only required 3,o at. At an ignition pressure of 3,- atm.the new motor-fuel did not ignite until a temperature of 600 degr.C.was reached.So long as the incandescent head could maintain this temperature,attained with the aid of a soldering lamp when the motor was started,the motor ran satisfactorly.The gradual drop in the temperature to that wich experience had shown to be the normal working temperature of the motor - 500°C - brought about an increasing demand of oxygen,and the imperfekt combustion resultant on the lack of oxygen ended finally in the motor coming to a standstill,since the highest compression wich it could produce was 6,2 atm.

Diesel engines.

7.ex. For experimetal purposes the spontaneous-ignition-curves of lignite motoroil,gasoil and of a mixture of gasoil with benzole were ascertained.These fuels were to be used for a stationary Dieselengine of diam.= 201 mm;stroke = 310 mm and n = 240 rev.p. min.The engine was provided with devices for indicating,making gastests etc.

The selfignition curve of the lignite motoroil showed the required ignition pressure to be reached at 34 XXXXXXXXXXXX atm.compression 2,2 atm.,as compared with 0,7 atm.for the gasoil and 4,6 at for the mixture of this gasoil with benzole.Therefore the use of gasoil resulted in a surplus of oxygen in the compression space of the engine, the use of the benzole mixture in a shortage of oxygen. Table 1 shows the results of the experiments, in so far as these are value for the objekts of investigation.

Table 1.

	lign.mot.oil	gasoil	gasoil +benzol
mean ind.press.atm	6,41	5,71	7,05
indic.power HP	16,87	14,97	18,06
sp.fuel hourly kg/HP	0,151	0,203	0,13
sp.weight of fuel	0,892	0,870	0,874
l.prim.value pr.degr.	7,8	15,4	4,25
h. " "	540	520	600
sp. " " "	7,0	12,7	4,9
vaporis.no. %	42	56	65
pr.val.Ce.nomber			
CO_2	3,8	3,7	6,8
cont.of exh.gases O_2	12,2	14,-	6,2
CO	0,5	0,65	5,4
mean no.of rev p.min.	240	240	240

Remarks: When the motor was run with the gasoil-benzole mixture, the ignition failed frequentely. After running 10 minutes, the engine came to a standstill in consequence of the great accumulation of soot.

Miscellaneous:
(lubricating oil; heating oil etc.)

8.ex. An explosion took place in the compressor room of a work and tore a piece out of the piping, about 0,17 sq.m in size. The point of fracture was at a considerable distance from the compressor, in the immediate vicinity of a pipe bend leading into the open air, The working pressure was 7 atm. The preliminary investigation showed the inner walls of the piping to be covered with a thick layer of oil. Samples of the lubricating oil used were examined with the aid of the priming value tester, and the priming value of the oil used for lubricating the compressorcylinder found to be 1,15; of the motor-lubricating oil used for the bearings = 9,65°. The material of the piping was free from faults.

If the ratio of 120 oxygen bubbles per minute= 9 atm. be assumed, a pressure of approximately 20 atm was required for the cylinder-oil if the amount of oxygen required for spantaneous ignition at approximately 300°C was to be present, whilst the motor lubricating oil could ignite at 2,2 atm. To this must be added that the precipitated oil was continually enriched with oxygen by the warm air passing through. In consequence of faulty construction, large ~~piston of the compressor, and forced with the air~~ quantities of bearing oil were sucked up by the low pressure piston of the compressor, and forced with the air trough the valves into the piping. The high speed of the air current induced a degree of frictional head at the sharp edges of the valves to wich raised the temperature to almost tgat of the point of spantaneous ignition of the oil, furnishing the second condition required to cause selfindignition. An examination of the compressor showed oil charcoal on the valve heads, and one of the valves was damaged.
Apparently a spontaneous ignition of a mixture of air an vaporized lubricating oil had taken place XXXXXXXXXXXXXXXX

above the valves, first damaging the valve, and then sending a jet of flames in the piping. This had generated on its way futher oil gases from the lubricating oil covering the interior of the piping. The gases encountered a hindrance in the sharp bend, and the result was an explosible mixture whose ignition tore the hole in the pipe.

9.ex. A proff of the correctness of this XXXXXX explanation was furnished, 3 days after the above described piping explosion, by the fracture of the starting air piping when a Dieselengine was beeing started. The fracture was again about 2 m distant from the cylinder. Here again a layer of oil was found on the inner walls of the XXX piping, and the tests made with the priming valueshowed this to be lubricating oil. The extremely small small quantity of oil obtained by rising out the piping sufficed to eable tests to be made definitly proving the precipitate actually to consist of lubricating oil, and not, as might have been assumed for various reasons, of motor oil; a property of lubricating oil, its capacity of XXXXXXX actuating as many as 50 ignitions and upwards in the priming value tester when the oxygen is supplied intermittently, was useful for this test. A drop of the oil from the piping permitted itself to be ignited 23 times by a succession of oxygen jerks; whilst the motor oil only ignited 3 times. The lubricating oil was proved to be the same as that supplied as bearing oil for the above mentioned air compressor.

It may be assumed that in this case again the streaming of the starting XXX air past the sharp edges of the check valve gave rise to a temperature closely approaching the selfignition point, causing the first ignition. Wether the second ignition, fracturing the piping, was brought about by lubricating oil or motoroil gases, may be left an open question. This damage to the piping of such different machines may therefore be attributed in both cases to a too generous lubrication with an oil easily inclined to spontaneous ignition. Frequent tests of the lubricating oils used therefore enable such accidents, wich are often more serious in XXX their results, to be avoided.

10.ex. An attempt was made to run an oil boiler plant with a heating oil other than that hitherto employed, with the result that th amount of steam required to drive the engine could not be generated. The examination showed that the selfignition point of the new oil was 430°C, the minimum ignition value beeing 2,2 pd, as compared with 260°C and 13 p.d. in the oil before used. The cause of failure of the plant lay in the fact that whilst the existing air supply equipment sufficed for the former fuel, it could not supply the amount of oxygen XXXXXX required for the transformation ignition, and combustion of the new heating oil. After an oil of high priming value and low spontaneous ignition point had been obtained the plant regained its customary efficiency.

11.ex. In an other boiler heating plant the easily inflammable XXX fuel usually employed was erroneously replaced by a fuel requiring a large amount of oxygen. The result was that as soon as an oilboiler was lit, an explosion took part in the upper boiler parts, damaging the chimney etc. Here again we may take the cause of the explosion to have been the circumstance that the existing air supply equipment did not suffice for the combustion of an oil slow to ignitie. In consequence of this large quantities of unburnt oil escaped into the upper parts of the boiler, accumulated here, and finally exploded. - As in both cases the selfignition point lay more than 100°C higher than taht of the oil formerly used, the ascertainment of this fact alone would have sufficed to avoid this trouble and damage.

12.ex. The insulating material hitherto employed for insulating spaces to be kept cool on ships beeing no longer obtainable, another similar material was used. Several mysterious fires on ships followed, and the explanation of their origin was not found until one fire was discovered to have commended at a spot where a welder had welded a 120 mm flange to an insulated board side a short time before. An examination of the old and the new insulation material showed that the maximum ignition value of the substitute material had alraedy been reached at 320°C, whilst the other material did not ignite spontaneously until 530°C. It was further ascertained that the new material continued to glow after beeing removed from the ignition chamber, whilst the old material cooled off immediately. The laboratory experiments were subsequently fully confirmed by the workshop tests undertaken afterwards.

13.Ex. Similar results were obtained in the course of experiments for ascertaining the spontaneous ignition point of a sunstitute for linoleum. Here again the results obtained in the laboratory experiments were fully confirmed by the subsequent workshop tests.

14.ex. Tests made of the self-ignition point of artificial leather as furniture covering again yielded very varying results. Whilst some materials did not reach their maximum priming value until over 500°C, others ignited at temperatures as low as about 300°C. It is obvious that such materials are not suitable for the furniture on board of ships, or for aeroplanes or railway carriages and that the technical regulations should stipulate a definite priming value for these purposes.

Concluding remarks:

The observations made in actual praktice thus show it to be possible, after the registration of the selfignition curve, to form a judgment on the suitability of a liquid fuel for any special purpose. When forming this judgment, it must at the same time not be forgotten that many motor oils are unsuitable in any case for certain types of machinery. Heavy oils, for instance, however finely nebulised, will scarcely be able to guarantee permantly satisfactory working in carburettor motors, as they reliquify on the comparatively long way before ignition.

The selfignition curve gives the designer a working base, enabling him to supply the economicalls most suitable motor to the purchaser obliged to make use of some definite motor oil. It enables the motor owner to feed his mechanical horses with the fuel wich best agrees with them. When there are breakdowns and other trouble, the selfignition curve eables it to be ascertained wether the fault lies with the engine or with the fuel.

For many motor fuels, as also for lubricating and heating oils, the securing of a certain priming value in relation to a certain temperature often suffices in itself to ensure a guarantee of the suitability of these materials for certain purposes.

In order to differentiate between petrol, benzole, lignite tar oils, coal tar oils etc. the determination of the spontaneous ignition point suffices.