ACIDITY AND MEASURES OF INADEQUACY OF TURBO OIL FOR USE IN COMPRESSORS

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ABSTRACT

There are some apparent changes , such as color, that may be found to take place in oils which are used in steam operated compressors . They may be accompanied by little changes in acidity as can be seen in CO_2 compressors. These changes do not have any tangible effect on the performance of the oil and its suitability for use in compressors . The oil characteristics remain satisfactory unless effective oxidation occurs due to elevated temperature or due to the presence of some other factors that may speed up the oxidation process and consequently affect the performance. In this paper measurements of viscosity and acidity of turbo-46 oil used in four different compressors together with the observation of oil color during operation have shown that only acidity and not color can be taken as a measure of inadequacy for practical use in compressors

Keywords: Lubricants, Acidity, Turbo Oil, Viscosity, Oxidation

INTRODUCTION

The presence of acidity in lubricating oils is due to different sources present during the lubrication process. An important one is due to the oxidation of the oil. The heat transmitted from turbine rotors to bearings tends to speed up the oxidation of the lubricating oil. Oxygen combines with oil molecules and forms carboxylic groups of the organic acids [1]. This type of acidity causes a change in the base fluid of oil and slightly increases the viscosity of the oil and also darkens its color. The undesirable effect of the acids formed is the bearing corrosion. The rate of oxidation increases with increasing temperature and also with the presence of catalytic substances in contact with oil, such as iron, copper and water which initiate the oxidation process [2]. The acidity caused by carbon dioxide does not affect the viscosity of the oil and consequently its specifications. This phenomenon is observed only in CO_2 compressors [2]. On the other hand the color of the oil is customary taken to be a measure of failure to meet the recommended specifications. This is not always the case as for example some oils contain detergent additives which keep the organic impurities suspended in the oil. These oils darken quickly while their specifications do not change. Some other oils may also get darker in color due to the formation of complex color compounds. Such change in oil color is not accompanied by a variation in oil characteristics. Therefore, the change in oil color cannot be taken in general as an indication of the inadequacy of the oil for use in industrial applications. It is the aim of this paper to examine this point especially for turbo oil for use in compressors.

EXPERIMENTAL WORK

The experimental procedure carried out in this work on the turbo oil used in different compressors is concerned with measuring the change in acidity and viscosity during operation for ten months from summer to spring seasons. The change in oil color was also observed during the same period. The measured experimental data are for turbo 46 tank oil used in generator compressor, CO_2 compressor, air compressor and gas compressor and are collected in Table 1.

Table 1 Measured values of acidity and kinematic viscosity of oil for different compressors .

Time (Month)	Generator compressor tank oil (Turbo 46)		CO_2 compressor tank oil (turbo 46)		Air compressor tank oil (Turbo 46)		Gas compressor tank Oil (Turbo 46)	
	Acidity mg KOH /g oil	Kinematic viscosity c.S.	Acidity mg KOH /g oil	Kinematic viscosity c.S.	Acidity Mg KOH /g oil	Kinematic viscosity c.S.	Acidity Mg KOH /g oil	Kinematic viscosity c.S.
0	0.110	45.10	0.350	45.10	0.103	45.50	0.081	44.90
1	0.144	44.80	0.199	44.40	0.050	44.70	0.053	44.30
2	0.131	45.10	0.162	44.50	0.073	45.00	0.077	45.10
3	0.149	45.30	0.294	44.80	0.079	45.10	0.063	45.20
4	0.134	45.10	0.331	44.70	0.089	45.00	0.064	44.55
5	0.220	44.95	0.370	44.62	0.110	44.94	0.090	44.55
6	0.130	44.86	0.270	44.50	0.085	45.04	0.067	44.55
7	0.090	44.90	0.230	44.50	0.060	44.94	0.050	44.45
8	0.080	44.95	0.080	44.50	0.050	44.94	0.050	44.35
9	0.106	44.81	0.166	44.50	0.075	44.84	0.078	44.68

The determination of acidity according to the I. Pstandard method D974 [3] is applied here. For the determination of the total acidity, the sample oil is dissolved into a solvent and the solution is titrated with 0.1 N alkali. The inorganic acidity is determined by extracting the sample with warm water and titrating the extract with 0.1 N alkali . The kinematic viscosity is also measured according to the I.P. standard method D445 [3]. The time is measured in seconds for a fixed volume of liquid flowing under gravity through the capillary of a calibrated viscometer under a reproducible driving head and at a closely controlled temperature. The kinematic viscosity is calculated from the product of the measured time of flow and the calibration constant of the viscometer.

RESULTS AND DISCUSSION

Figures 1-4 show the kinematic viscosity of the tank oil of various type of compressors versus acidity. It is clear that irrespective of the value of the oil viscosity the change in acidity over a period of 10 months is quite small as can be seen from the straight line correlation given by a dashed line on each plot. Figures 5 to 8 show the time variation of the kinematic viscosity of the tank oil over the 10 months period for the four types of compressors selected. A slight decrease in viscosity with time is noticed from the correlation of the results for the cases considered. This is best demonstrated when the results for all types of compressors are grouped as shown in Figure 9.

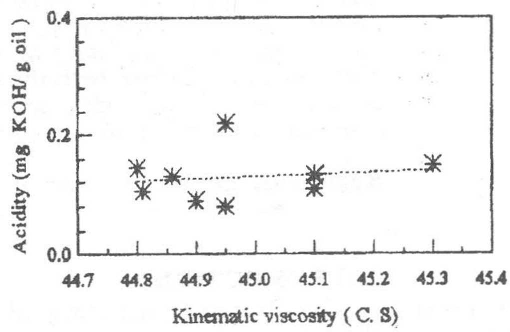

Figure 1 The relationship between acidity for generator compressor tank oil (Turbo 46)

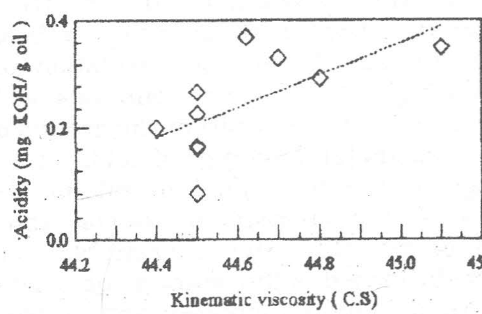

Figure 2 The relationship between acidity and viscosity for CO_2 compressor turbine tank oil (Turbo 46)

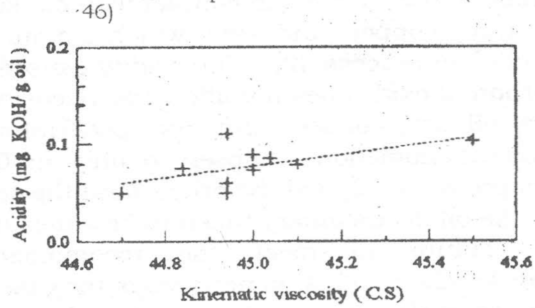

Figure 3 The relationship between acidity and viscosity for air compressor turbine tank oil (Turbo 46)

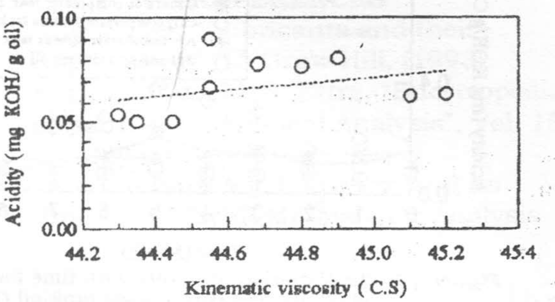

Figure 4 The relationship between acidity and viscosity for gas compressor turbine tank oil (Turbo 46)

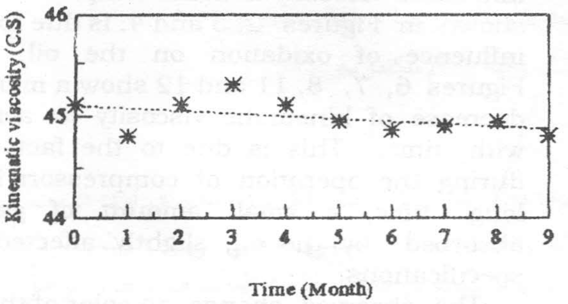

Figure 5 The variation of kinematic viscosity with time for generator compressor tank oil (Turbo 46)

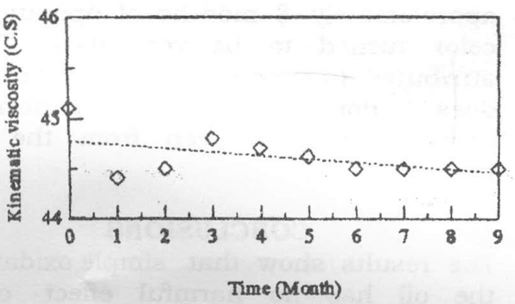

Figure 6 The variation of kinematic viscosity with time for CO_2 compressor turbine tank oil(Turbo 46)

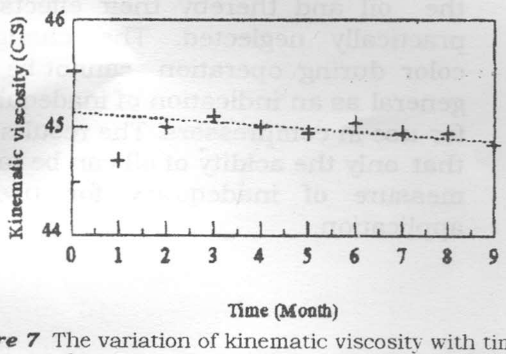

Figure 7 The variation of kinematic viscosity with time for air compressor turbine tank oil (Turbo 46)

The average value of the viscosity is shown by a continuous line and the dashed line is concerned with the correlation for the data in general. On the other hand, the time variation of acidity of the tank oil over the same period is given in Figures 10 to 13. The results show that the acidity remains below the allowable value recommended in specifications for industrial applications namely from 0.3 to 0.35 mg KOH/g oil [4]. When the results are reproduced and grouped in Figure 14, it is clear that although the same turbo 46 oil is used in all compressors mentioned in this work, the acidity of CO_2 compressor oil is somewhat higher than that for the other compressors oils. This means that the extra acidity is due to CO_2 and not due to oxidation explaining the reason for the viscosity of the oil to remain practically unaffected (see Figure 9).

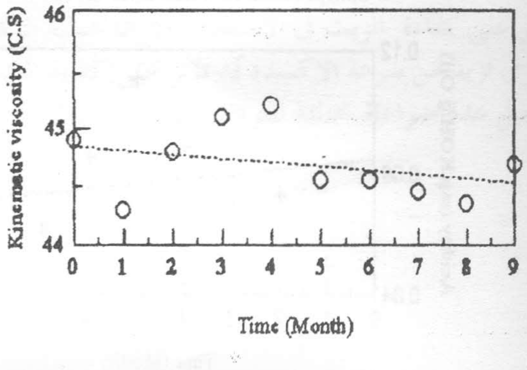

Figure 8 The variation of kinematic viscosity with time for gas compressor turbine tank oil (Turbo 46)

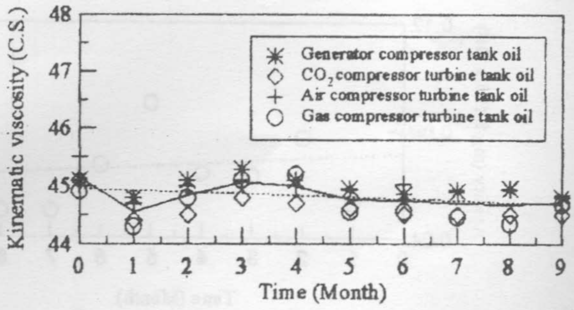

Figure 9 The variation of kinematic viscosity with time for tank oil different compressor (Turbo 46) (___ mean value, ------ correlation)

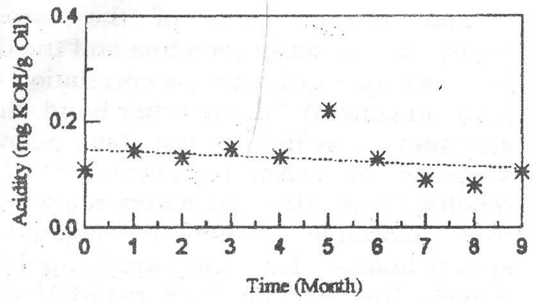

Figure 10 The variation of acidity with time for generator compressor tank oil (Turbo 46)

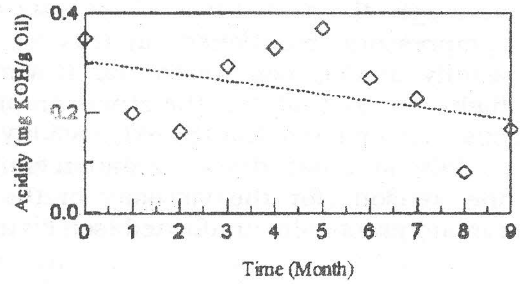

Figure 11 The variation of acidity with time for CO_2 compressor turbine tank oil (Turbo 46)

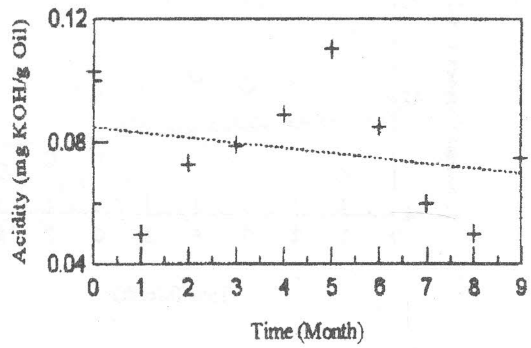

Figure 12 The variation of acidity with time for air compressor turbine tank oil (Turbo 46)

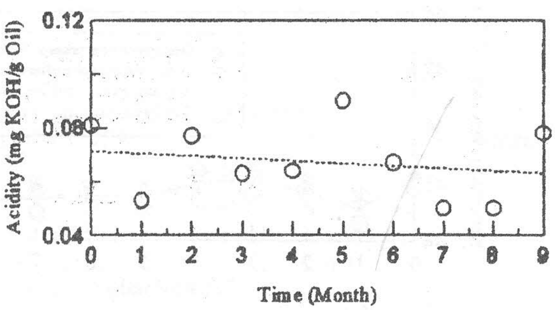

Figure 13 The variation of acidity with time for gas compressor turbine tank oil (Turbo 46)

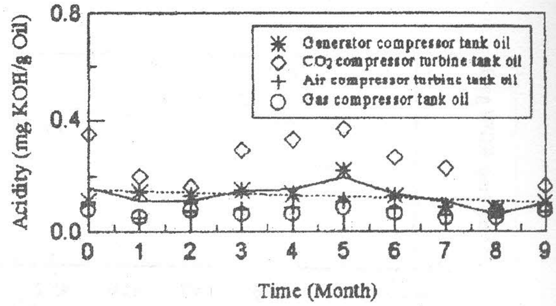

Figure 14 The Variation of acidity with time for tank oil of different compressor tank oil (Turbo 46)

A clear increase of acidity with the kinematic viscosity in some compressor oils shown in Figures 2, 3 and 4, is due to the influence of oxidation on the oil. Also Figures 6, 7, 8, 11 and 12 show a marked decrease of kinematic viscosity or acidity with time. This is due to the fact that during the operation of compressors for a long time, a small amount of gases, absorbed by the oil, slightly affected its specifications.

The observed change in color of the oil for all compressors, during the course of measurements of viscosity and acidity, is found to be quite noticeable. As after approximately 8 months of operation the color turned to be very dark. This is attributed to simple oxidation of the oil and does not affect its performance characteristics as seen from the above results.

CONCLUSIONS

The results show that simple oxidation of the oil has no harmful effect on the performance. As few quantities of oxidant substances formed are able to dissolve in the oil and thereby their effects can be practically neglected. The change in oil color during operation cannot be taken in general as an indication of inadequacy of oil for use in compressors. The results indicate that only the acidity of oil can be taken as a measure of inadequacy for use in this application.

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الحمضية و مقاييس عدم صلاحية الزيوت المستخدمة فى الضواغط

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ملخص البحث

توجد بعض الظواهر والتغيرات التى تطرأ على زيوت التزييت المستخدمة فى محركات الضواغط مثل التغير فى لون الزيت ودرجة الحمضية وخاصة فى ضواغط ثانى أكسيد الكربون و ولكن هذه التغيرات لا تستلزم بالضرورة تغير الزيت حيث انها لا تؤثر على كفاءة الزيت فى الاستخدام الا ان عملية الاكسده التى تحدث للزيت نتيجة درجات الحرارة العالية مع وجود عوامل اخرى تزيد من سرعة الاكسده قد تؤثر على كفاءة التشغيل ويتبين ذلك بقياس اللزوجة ودرجة الحمضية للزيوت المستخدمة فى تشغيل عدة ضواغط مختلفة لفترات زمنية .