Experimental Study for Cleanliness Evaluation of Tractor Engine Components

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Abstract

In present scenario most of the industries are competing for quality improvement. In each automotive company, to reduce the wear and tear between engine components and to increase the engine life, it is necessary to check the contamination level of engine components. To wash these components washing solvents or multi metal cleaner cum degreaser are used to wash the components in ordinary or ultrasonic washing machines. In this paper experimental work is carried out to find the life of two washing solvents used to wash the tractor engine components in ordinary and ultrasonic washing machines. This experiment is performed at different setting parameters date wise of both of the machines. Observations were taken for 15 days using two type of cleaning medium i.e. AFSO CLEAN-AD20 and METACLEAN 211. After data analysis it is concluded that if these washing solvents are used for both shifts in the industry than the solvents remain useful to clean the tractor engine components for 6 days as per specification limits.

Keywords: Contamination level, Washing solvent, washing life, Millipore value, ultrasonic washing

1. Introduction

It is very much clear that presently tractor manufacturing are using different types of washing solvents to remove the contaminants from various tractor engine components. It is necessary to wash or clean the components before forwarding to assembly line [1]. If components having contamination level higher than a standard value than it will impact the quality and will increase wear and tear between metal surfaces of components. Different methods are used by industries to evaluate a cleanliness level [2, 3]. In the case company, Millipore method is used to remove contaminates from the sample parts by brushing and flushing with a solvent and filtering the solvent to remove the contaminants and then determining the quantity and nature of the contaminants removed.
The brushing and flushing procedure does not yield complete removal of contaminants present but with good practice a 50% yield will be obtained discrepancies can occur thus sufficient brushing and flushing [4, 5]. Also foreign particles can become trapped in the brushes, cleaning brushes before the check is essential.

2. Methodology

The method used in this project supplements the concept of ideal cleanliness of engine parts and related system. Instructions should be provided to apply this method using only nylon filter and tri-chloro ethylene. A consistent and precise technique is essential to obtain valid, reproducible results and special instructions for the application for this method to certain engine parts, are followed during the project.

2.1 Equipment

Millipore Equipment (Shown in Figure 1) including filter paper and sample disks filter paper size 0.45 Microns (Nylon Filter)-for filtering (T.C.E.) 5.0 Microns (Nylon filter)-for normal sample is used in this experimental study to calculate the life of washing solvents.

Fig.1: Filtration equipment for contamination.

1. Filter funnel
2. Holding Fixture for filter membrane
3. Vacuum pipe
4. Vacuum flask
5. Rubber stopper

Other items used with this equipment are as follows:
- Balance scale-reading upto 0.1 MG.
- 2x2” (51cm X 51cm) diameter plastic specimen plugs sanded smooth.
- Tri- Chloro Ethylene in a bottle for easy application. Normal usage is 200-400 ML per part. Incoming solvent is to be sample checked for cleanliness.
- Brushes-white Nylon bristle brushes to use unless otherwise specified round brushes for cleaning holes to be larger diameter than holes to be cleaned. Denature brushes are not acceptable.
- Receptacles to collect sample trays, jars, pans adapters as needed.
2.2 Parts or components selection for cleaning
Engine parts must be demagnetized prior to cleaning to aid the cleaning process. Limits of acceptance for residual magnetism shall be as outlined in inspection standard. Parts such as raw casting must be received from supplier at a cleanliness level as specified in inspection standard. Production parts shall be selected at random as per final wash but before final preservation, containerization or build up. Unless otherwise specified parts which are lubricated (from manganese phosphatized shall be inspected to this standard prior to treatment.

2.3 Method to use in washing and sample part
It is to rinse part with Tri chloro ethylene or equivalent catching fluid in the collection tray and brush water air, oil, fuel holes and bores using a brush larger than the holes size as specified in earlier.

Process for Brushing holes: When brushing holes, a spiral motion should be imparted to the brush taking care to avoid flipping particles from the bristles. Use a Nylon brush for holes and sash brush for bores. Note that brushing must be done in consistent manners with the following definition applying:
- Single stroke- movement in one direction only such as pulling or pashing a brush thru a hole bore.
- Double stroke- movement in both direction only such as pushing in and out of a blind hole or bore. All brushes are to be wetted in Tri chloro ethylene or equivalent.
- Flush the part and brushes with Tri chloro ethylene or equivalent catching all of the fluid in the collection tray.
- Brush and flush again as in above steps.
- Consistency in this washing and brushing operation is required to obtain reproducible results part. Care must be taken to prevent the solvent from contracting surface, which are not being evaluated.

Parts are submitted for refreshing after cleanliness checks are completed.

2.4 Filtering sampling solution
Sample is filtered using Millipore filtering apparatus, using 5-6 micron filter that has been previously weighted. After this steel pan or jars thoroughly washed and pour residue through the filter. If fluid sample is contained in one or more trays or jars of a given part sample, all fluid is to be filtered through the sample filter pad. When possible, note that vacuum of 15" (381 mm) Hg is to be maintained on the filter when introducing the sample. Normally only one part sample per filter pad.

2.4.1 Procedure of filtering solution
- Place the nylon filter pad on the analytical balance weigh and record the initial weight to the nearest tenth of milligram (0.0001) of the filter pad.
- Assemble the reweighted filter pad into the filter holder/apparatus.
- Pour the flushing solvent from the Millipore part into the filter apparatus.
- Rinse the container jar/steel pan two more times with clean solvent (TCE OR Equivalent) pouring the rinsing into the filter apparatus. Turn on the vacuum pump until the solvent has drained away from the filter apparatus.
When the solvent is drained away flush the sides of the filter funneled with clean solvent and allow to drain to way.

Turn off the vacuum pump, remove the filter pad and put into the drying oven (70°C Celsius) in its unsealed Petridis.

Remove the filter pad from the oven after the 30 minutes & allow to cool the room temperature.

Weight the filter pad and record final weight to the nearest length of milligram.

The contaminant level is difference between the initial weight of the pad and the final weight of the pad divided by the no. of part in the rest.

Remove the ferrous residue by means of a magnet and the ferrous content of residue.

Weight values may be excess of true dust values because of foreign impurities such as soap crystal residual oils brush bristles etc. if seem on the filter paper. These impurities should be noted down the evaluation.

3. Project Description

This experimental study is performed at a prestigious tractor engine manufacturing company situated in North Central Region of India. The case company has one of the oldest names in the field of tractor manufacturing sectors. The objective of the project is to find out the life of washing solvent/media in washing machine with respect to cleanliness level of Millipore value of Engine Components. During the study it was observed that the cleaning medium was not correctly mixed with water so it affects the contamination level of components. The study was carried out on two washing machines as ordinary washing and Ultrasonic washing machine. The washing solvent METACLEAN 211 and ASFOCLEAN – AD-20 in ordinary washing and Ultrasonic washing machine.

### Table 1 Operating instructions for Ultrasonic machines (Parameters to be maintained)

| Parameters             | I   | II  | III | IV  | Storage Tank |
|------------------------|-----|-----|-----|-----|--------------|
| Qty. of Water          | 75  | 55  | 55  | -   | 55           |
| Qty. of AD-20          | 5%  | 5%  | 1%  | -   | 5%           |
| Cleaning Medium ( Ltr.)| 4   | 3   | 0.5 | -   | 3            |
| Temperature(°C)        | 56  | 56  | 56  | 60  | -            |
| Cleaning cycle time (Min.) | 5   | 5   | 5   | 5   | -            |

Operating parameters in ultrasonic machine are given in Table 1. There are four washing tank in this machine. Fixed Quantity of water maintained in tanks. Percentage of AD-20 in three tank is used as 5%,5% and 1% respectively. Temperature maintained in four tanks at 56°,56°,56° and 60°C respectively.

### Table 2 Ordinary washing machine (setting parameters)

| Parameters        | Specifications |
|-------------------|----------------|
| Temperature(°C)   | 40-44          |
| Concentration %   | 3-5-8          |
| Pressure (Kg/cm²) | 3-6            |
| Washing Time(Min) | 3              |
Operating parameters of ordinary washing machine are followed as per Table 2. Temperature is maintained in range of 40°-44°C, concentration percentage was limited to 3-5-8%, pressure was set at 3-6 Kg/cm², and washing time was 3 minutes.

Table 3 shows different setting parameters date wise in ordinary washing machine. These values were noted daily when cleaning was performed.

| Date     | Temperature °C | Liquid Concentration % | Pressure (Kg/cm²) | Washing Time (Min) |
|----------|----------------|------------------------|-------------------|--------------------|
| 05/06/2020 | 43             | 10                     | 3.0               | 3                  |
| 06/06/2020 | 44             | 8                      | 4.2               | 4                  |
| 07/06/2020 | 43             | 6                      | 3.1               | 3                  |
| 09/06/2020 | 44             | 10                     | 4.0               | 5                  |
| 10/06/2020 | 45             | 8                      | 4.2               | 3                  |
| 11/06/2020 | 44             | 6                      | 3.3               | 4                  |
| 12/06/2020 | 43             | 8                      | 4.3               | 4                  |
| 13/06/2020 | 45             | 5                      | 3.0               | 4                  |
| 15/06/2020 | 44             | 10                     | 3.2               | 3                  |
| 16/06/2020 | 43             | 10                     | 4.0               | 3                  |
| 17/06/2020 | 44             | 8                      | 3.0               | 3                  |
| 18/06/2020 | 43             | 8                      | 3.2               | 5                  |
| 19/06/2020 | 45             | 10                     | 3.8               | 3                  |
| 20/06/2020 | 44             | 8                      | 4.0               | 4                  |

Table 4 shows different setting parameters on ultrasonic washing machine such as AD 20 strength, temperature, contamination and cleaning time of the components. These data were noted on daily basis when the experiments were performed. AD 20 strength was measured in percentage with water and maximum percentage was 10% while minimum was 1%. Temperature was also noted in all four washing tanks. It was found 56-57 degree in first three tanks while in fourth tank it was variable. Contamination level was measured in mg/100ml. Contamination was continuously increasing from 15.2 mg/100ml to 38.2mg/ml. During the cleaning process, cleaning time was also noted and it was 5-6 min.

Seven components were cleaned on ultrasonic washing machine using AFSOCLEAN AD 20 as the cleaning medium. Observations were taken for 14 days from 05.06.2020 to 20.06.2020 as shown in Table 5. Contamination trend of these components were calculated using Millipore equipment. Weight of the contamination was noted in mg/pc on digital weigh machine. Date wise results shown in Table 5. These data were compared with standard values of contamination specified by the suppliers. For example- for connecting rod (C1) it is 10 mg/pc. It is clear from the Table 5 that the contamination level comes within specification limits upto 12 days. After 12 days it goes beyond the specifications.
For connecting rod it was 2.4 mg/pc on 05.06.2020 and after 12 days of observations it increased to 10.5 mg/pc which is out of specification limit. Similarly, for R.A. Exhaust the contamination was 0.8 mg/pc on the first day and it increased to 2.4 mg/pc after 12 days that shows out of specification limit.

Table 6 shows the contamination trend on ordinary washing machine using METACLEAN 211 as cleaning medium. From the data it is clear that for protection sleeve, contamination level was 3.5 mg/pc on 05.06.2020 and it was found 5.8 mg/pc after 12 days. Similarly, it is clear from the observations that for all components, the cleaning media works satisfactory up-to 12 days only.
Table 6 Ordinary Washing Machine (Contamination Trend) Cleaning Medium METACLEAN 211

| Component | Specification | Actual (mg/pc) Date wise |
|-----------|---------------|--------------------------|
|           | Mg/pc         | 5/6/20 | 6/6/20 | 7/6/20 | 9/6/20 | 10/6/20 | 11/6/20 | 12/6/20 | 13/6/20 | 15/6/20 | 16/6/20 | 17/6/20 | 18/6/20 | 19/6/20 | 20/6/20 |
| C8        | 5             | 3.5    | 3.8    | 3.9    | 4.1    | 4.2    | 4.2    | 4.0    | 4.2    | 4.3    | 4.5    | 4.4    | 4.8    | 5.8    | 7.1    |
| C9        | 20            | 12     | 12     | 13     | 14     | 14     | 15     | 17     | 17     | 19     | 19     | 20     | 20     | 20     | 25     |
| C10       | 25            | 8.1    | 10     | 13     | 13     | 15     | 17     | 17     | 18     | 21     | 24     | 24     | 25     | 26     | 31     |

C8-Protection sleeve, C9-R.A.Housing, C10-Lid cover

4. Conclusion/recommendations:

It was observed from experimental study that if these washing solvents (AD-20 & METACLEAN 21) is used for both shift than these clean the components properly upto 06 days. After that the cleaning quality does not get upto standard level. If these washing media solvents will be used in single shift than it will clean the components upto 12 days max. If these are used beyond 12 days the component cleanliness level goes beyond the specification/standard.

The paper presented the experimental work for calculating life of washing media/solvent used in ultrasonic and ordinary washing machine. In the experiment components from tractor engine were collected for daily contamination checking and after washing in ultrasonic and ordinary washing machine, It was found that after 12 days the contamination of the component cross their specific value of contamination level.

Suggestions:
- The proportion of washing media with water should be correct.
- The tanks of the washing machine should be cleaned time to time.
- There should not be any dirty material around the washing machine.
- The time taken in washing machine the components should be correct.
- The tray in which the components are kept for washing should be washed.
- The contamination of the components washing in machine should be checked time to time.
- When the contamination of the components get their specification value. Then washing liquid should be changed.

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