DENSO

Report of Machine Oil Mass Balance Testing Performed at DENSO Manufacturing Michigan, Inc. Battle Creek, Michigan

Report Date:
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Appendices

I. Introduction

DENSO Manufacturing Michigan, Inc. (DMMI) produces automotive heat exchangers; including heaters, radiators, condensers and evaporators. These parts are produced from rolls of aluminum, which contain a cladding layer on the surface of the metal. The aluminum is lubricated with machining oil to facilitate the formation of aluminum tubes and fins. The tubes and fins are temporarily connected by metal wires to form the various heat exchanger parts. The machining oil must be removed from the tubes and fins in an oven degreaser, before they can be permanently attached in the brazing furnace. A portion of the oil evaporates as fugitive emissions from the cores before entry into the oven degreaser.

During brazing, the parts are heated to a point where the cladding layers melt and the material flows together. Upon exiting the furnace, the parts are cooled by fans, which re-harden the cladding material, resulting in permanently joined fins and tubes.

The machining oil used to facilitate forming of components for the various heat exchanger parts is currently recognized as containing volatile organic compounds (VOCs). On some manufacturing lines, the oil is subject to evaporative loss from the time the cores are formed until they enter the oven degreasers. On other lines, the cores are directly fed into the degreasers with no staging and no evaporative loss of oil.

Testing to determine the amount of evaporative loss of forming oil from cores in each product group produced at DMMI (condenser, evaporator, heater core, and radiator) was conducted to fulfill conditions specified by DMMI's Renewable Operating Permit MI-ROP-N1192-2017c and Permit to Installs 94-18 and 138-17.

The testing was performed in accordance with the test protocol approved by MDEQ. All inquiries related to the testing conducted and contents of this report should be directed to:

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The following individuals took part in the evaporative loss testing.

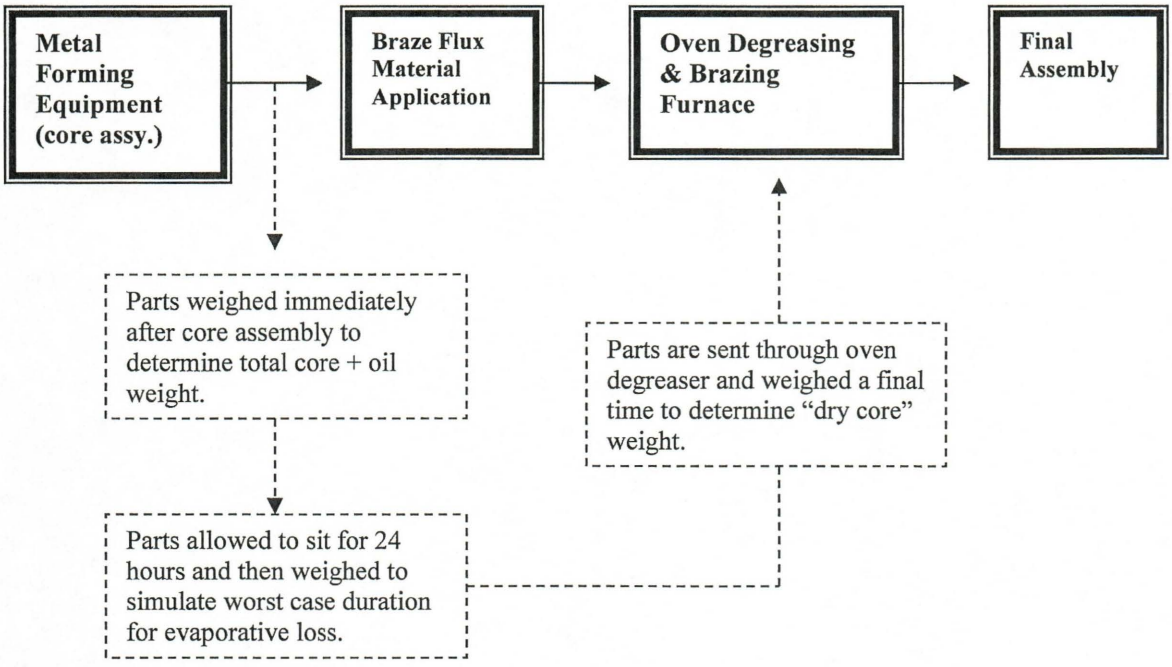
Justin Jones – Evaporator & Heater Core
Jeremy Dreps – Radiator
Ralph Crim- Condenser

II. Summary of Results

Section II Table 1 Machining Oil Evaporative Loss Rate Determination Results DENSO Manufacturing Michigan, Inc. Battle Creek, Michigan			
Area	**Test Dates**	**Part Numbers Tested**	**Evaporative Loss Rate***
Evaporator	11/29-30/2022	CUSW CD6 180L	15.8%
Radiator	11/21-22/2022	1980 600 2221	21.1%
Heater Core	12/8-9/2022	3070 6970 3440	29.8%
Condenser	12/8-9/2022	GC7 010B DS	18.9%
** Forecasted production rates of parts are factored into the evaporative loss rate calculation*			

III. Source Description

The portions of the manufacturing processes involved for each product type tested are similar. As stated above, metal forming equipment is used to form fins and tubes from rolls of aluminum. The aluminum is lubricated with machining oil to facilitate the formation of fins and tubes. End plates and other components of the cores are stamped. All of these components are then bound together by wire wrapping machines in preparation for oven degreasing. The diagram below illustrates the process flow and general steps of the testing process.



Pollution control for VOC emissions occurs at the oven degreaser exhaust. Exhaust from the oven degreaser is routed through a thermal oxidizer, except for C924 and E124 degreasers. The presence of the thermal oxidizer has no bearing on the outcome of the evaporative loss determination test because this test only measures the total oil on cores and the oil which evaporates prior to degreasing. Monitoring of process related instrumentation is not applicable to this test.

IV. Sampling and Analytical Procedures

The test procedure is included on the following two pages.

1.1 PURPOSE

To provide a standard procedure for determining the evaporative loss rate of forming oil from the time parts exit the core assembly process until they enter the oven degreaser, as required by our air permits. This procedure will also provide a method for determining the average amount of forming oil used per part produced.

1.2 SCOPE

This testing procedure will apply to all core manufacturing processes at DMMI.

1.3 RESPONSIBILITY

The Production Engineering departments will conduct the testing at the request of the Environmental Department.

1.4 ACTIONS AND METHODS

1.4.1 Determination of representative sample

1.4.1.1 Environmental Section will evaluate permit conditions and communicate testing requirements and other necessary information to appropriate personnel in the Production Engineering departments. This information will include:

- Purpose of the test
- Specific production line and/or machines involved
- Any specific testing procedure requirements noted in a permit condition
- Due date for completion of testing

1.4.1.2 Production Engineering will provide the following information

- Part numbers produced in affected area and surface area of each part number
- Available production forecast for each part number

1.4.1.3 The Environmental Section will provide the test plan to the AQD District Supervisor for approval if required by the air permits and notify the District Supervisor or Compliance Support Unit at least 7 days prior to anticipated testing dates.

1.4.2 Testing Procedure

1.4.2.1 Sample lot will consist of five assembled cores of each part number.

1.4.2.2 Cores should be stacked by part number to simulate actual process conditions. Weigh each core with a scale capable of reading to the tenth of a gram and record the results. **(= a)** Also record the date and time.

1.4.2.3 Place stacked cores in a container capable of collecting and containing any forming oil that drips. The purpose of the container is to ensure that oil does not create a slip hazard by dripping onto a walking surface. However, the container must allow exposure of parts to the general plant air to simulate typical conditions for evaporative loss.

1.4.2.4 Wait for a period of time representative of the parts being processed after forming/core assembly. Record the time elapsed and the rationale used for determining the waiting period. Then weigh each core and record the results. **(= b)** Also record the date and time.

1.4.2.5 As soon as possible after weighing, send all of the test cores through the oven degreaser (in some areas, the flux application will have to be bypassed) and then weigh each core. This will provide the "dry core" weight. **(= c)** Also, record the date and time.

1.4.3 Summary Evaporative Loss Calculations

Total Evaporative Loss per Group = (a - b) = **d**
Total Oil Use per Group = (a – c) = **e**
Evaporative Loss Rate per Group [expressed as percentage] = (d / e) * 100 = **f**
Average Oil Use per Part = e / 5

Projected production rates shall be considered when permit conditions require evaporative loss testing for an area or process where multiple part numbers are produced. Allocate a **percentage of projected production** to each part number tested. **(= g)**

- Example: Part "X" = 30% of projected production for area
  Part "Y" = 50% of projected production for area
  Part "Z" = 20% of projected production for area

To determine average evaporative loss rate for an area, determine total lbs VOC emitted per ton oil used for each part, sum these totals and divide by 2000.

- Example lbs VOC emitted per ton oil used:
  Part "X": (2000 lb/ton oil) * % VOC content * (g) * (f) = **h**
  Part "Y": (2000 lb/ton oil) * % VOC content * (g) * (f) = **i**
  Part "Z": (2000 lb/ton oil) * % VOC content * (g) * (f) = **j**
  Total lbs VOC emitted per ton oil used = (h + i + j) = **k**

Average Evaporative Loss Rate [expressed as percentage] = (k/2000) * 100

1.5 REFERENCES

Applicable Permits To Install issued by the Michigan Dept. of Environmental Quality

1.6 RECORDS

Records shall be maintained as outlined under Records Procedure #ENV-454-01.

1.7 Reporting

Submit a complete report of the test results to the AQD District Supervisor within 60 days following the last day of the test.

END

V. Test Results and Discussion

The results of the evaporative loss rate determinations for each of the affected process areas are presented in Table 1 of Section II of this report. The evaporative loss rates were determined using the procedures and calculations described in the test procedure presented in Section IV.

Actual test data and associated calculations are presented in Appendix A of this report.