Asphalt Extraction Study

WA-RD 165.1

Task Report
November 1988

Washington State Department of Transportation
Planning, Research and Public Transportation

in cooperation with the
United States Department of Transportation
Federal Highway Administration

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ASPHALT EXTRACTION STUDY

by

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Washington State Department of Transportation
Materials Laboratory

Task Report

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16. ABSTRACT

This study compares the results of four asphalt extraction methods; the Quick (WSDOT 711), the Vacuum (AASHTO T-164 Method E-11), the Centrifuge (AASHTO T-164 Method A), and the Reflux (AASHTO T-164 Method D).

The methods are compared on the basis of the amounts of trichloroethane used, the exposure to trichloroethane while testing, the time needed to do the testing, and the accuracy of the asphalt content and aggregate gradation determinations (with the Reflux method serving as the standard of comparison).

It was concluded that the Quick method was still the best alternative to the Reflux method, based primarily on the speed of the test and its close agreement with the Reflux method on asphalt content and percent passing the #200 sieve. All methods provided exposure to trichloroethane vapor well below the recommended allowable levels.

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The researcher appreciates the efforts put forth by the materials laboratory technicians from District 1, District 5, and Headquarters who painstakingly performed the 150 extraction tests involved in this study. Their dedicated efforts and attention to detail insured the validity of the data collected.

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ABSTRACT

This study compares the results of four asphalt extraction methods; the Quick (WSDOT 711), the Vacuum (AASHTO T-164 Method E-11), the Centrifuge (AASHTO T-164 Method A), and the Reflux (AASHTO T-164 Method D).

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INTRODUCTION

PURPOSE

The purpose of this study was to compare test data from the Quick (WSDOT 711), Vacuum (AASHTO T-164 Method E-II) and Centrifuge (AASHTO T-164 Method A) asphalt extraction test procedures with the Reflux (AASHTO T-164 Method D) asphalt extraction procedure used as the control.

OBJECTIVE

This study compared the amounts of trichloroethane used, the exposure to trichloroethane while testing, the time needed to do the testing, the asphalt content and the aggregate gradation as determined by each test procedure.

BACKGROUND

There has been a concern for some time that there may be a more efficient and safer test procedure than the Quick extraction test procedure now used for gradation acceptance of asphalt concrete pavements in the State of Washington.

Samples of asphalt concrete mixes were gathered from three different asphalt plants. Three different laboratories and their respective testing personnel were used to generate the data.

Preliminary comparisons performed by District 5 indicated that a modified version of the Centrifuge extraction could provide acceptable test results in a shorter time while affording lower exposure to trichloroethane vapors. This study was established to evaluate this claim on a controlled test comparison between multiple laboratories.

DATA AND ANALYSIS APPROACH

PRELIMINARY ORIENTATION

An Orientation meeting was set up and held in the Headquarters Laboratory with the people from the three laboratories to discuss the procedures and lay down the guidelines to be followed. Discussions were held and certain guidelines were developed so that everyone would test their samples the same to minimize procedural deviation.

The guidelines were:

1. Splitting Samples

   a) Heat sample in a 230+/-9 F oven for approximately three hours.

   b) Empty sample box onto a tarp or large sheet of paper.

   c) Roll sides of paper toward center.

   d) Use a suitable divider and split sample in half.

   e) Turn divider 90 degrees and split each of the two piles in half, work a space between halves.

   f) Remove opposite quarters and return them to box.

   g) Mix the remaining two quarters.

   h) Repeat c)through g) until a sample of approximately 1000 grams is obtained.

2. Heat the samples to 230+/-9 F and dry to a constant weight.

3. All weights were recorded to the tenth of a gram.

4. Measure trichloroethane used to wash aggregate and that used for cleaning equipment.

5. Sieve clean aggregate through Class B specified screens (5/8, 1/2, 3/8, 1/4, #10, #40, #80 & #200).

6. Sieve for 10 minutes in a suitable shaker.

7. Record "Begin Washing" time when trichloroethane was added to mix.

8. Washing time will include filtering time for the Vacuum and Quick extractions.

9. Record "Begin Drying" time when aggregate was placed in an oven and when silica or filter was placed in oven.

10. Record "End Drying" time when aggregate and silica or filter reached a constant weight.

11. Constant weight for this evaluation is defined as two weighings, ten minutes apart, that are within one-tenth of a gram of each other.

12. Total extraction time will not include sieve analysis.

13. If an error is suspected, finish the test and rerun the test with remaining ACP, report both results.

SAMPLE ACQUISITION AND DISTRIBUTED

The asphalt concrete was obtained by HQ Materials people from three commercial sources. These sources were coded as (L) Lacey, (K) Kent and (R) Redmond. The bulk samples of Class B mix were split to provide separate box sized samples of approximately 15 pounds. Each laboratory was provided 5 samples for each procedure as follows:

Laboratory One (District 1)

Quick	L1A	L2A	L3A	L4A	L5A	K1A	K2A	K3A	K4A	K5A
Vacuum	L1B	L2B	L3B	L4B	L5B	K1B	K2B	K3B	K4B	K5B
Centrif.	L1C	L2C	L3C	L4C	L5C	K1C	K2C	K3C	K4C	K5C

Quick	R1A	R2A	R3A	R4A	R5A
Vacuum	R1B	R2B	R3B	R4B	R5B
Centrif.	R1C	R2C	R3C	R4C	R5C

Laboratory Two (District 5)

Quick	L1D	L2D	L3D	L4D	L5D	K1D	K2D	K3D	K4D	K5D
Vacuum	L1E	L2E	L3E	L4E	L5E	K1E	K2E	K3E	K4E	K5E
Centrif.	L1F	L2F	L3F	L4F	L5F	K1F	K2F	K3F	K4F	K5F

Quick	R1D	R2D	R3D	R4D	R5D
Vacuum	R1E	R2E	R3E	R4E	R5E
Centrif.	R1F	R2F	R3F	R4F	R5F

Headquarters Laboratory

Quick	L1G	L2G	L3G	L4G	L5G	K1G	K2G	K3G	K4G	K5G
Vacuum	L1H	L2H	L3H	L4H	L5H	K1H	K2H	K3H	K4H	K5H
Centrif.	L1I	L2I	L3I	L4I	L5I	K1I	K2I	K3I	K4I	K5I
Reflux	L1J	L2J	L3J	L4J	L5J	K1J	K2J	K3J	K4J	K5J

Quick	R1G	R2G	R3G	R4G	R5G
Vacuum	R1H	R2H	R3H	R4H	R5H
Centrif.	R1I	R2I	R3I	R4I	R5I
Reflux	R1J	R2J	R3J	R4J	R5J

STANDARDIZATION OF PROCEDURES

Each laboratory performed the Quick extraction method, Vacuum extraction method and the Centrifuge method. The HQ Laboratory performed the Reflux method. (See Appendix A for description of the test methods.)

For the afternoon and next day orientation session two people from each laboratory spent time in the HQ asphalt lab for hands on testing to familiarize them with the test procedures.
Each laboratory was designated to perform the testing in their normal asphalt testing lab. Pictures of each installation are in Appendix B.

The technician doing the testing wore coveralls, gloves, eye goggles and a respirator.

TRICHLOROETHANE FUME MONITORING

Vapor monitors were used to check the exposure level experienced during the evaluation. Procedures were established as follows:

1. Two vapor monitors to be used per each type extraction procedure.

2. A maximum of eight exposure hours per monitor.

3. Monitor to be used for one day only. (Even if the extraction period is less than eight hours.)

4. Wear monitor for the same type of extraction only.

5. Stay in extraction area during extraction procedure.

6. Return all monitors in the original can with paperwork to HQ Lab after completing the extraction evaluation.

7. Follow instruction on monitor can.

8. When beginning the extraction procedure open the can and attach the monitor to shirt collar.

9. Record start time and the monitor number on sheet provided and on the original can.

10. When finished extracting test samples for the day, record stop time and calculate the elapsed time. Seal monitor as per instructions and store away from the extraction area.

11. Record the sample numbers tested and millimeters of trichloroethane used during monitoring period.

RESULTS

The asphalt extraction study involved four different procedures (a copy of each procedure is located in Appendix A), namely:

1. The Reflux Extraction procedure WSDOT Test Method 710, AASHTO T-164 Method D.

2. The Quick Extraction procedure WSDOT Test Method 711.

3. The Vacuum Extraction procedure AASHTO T-164 Method E-II.

4. The Centrifuge Extraction procedure AASHTO T-164 Method A modified by elimination of any procedure for correction for fines lost through the filter ring.

The data (a copy of all data is found in Appendix C) used to evaluate the extraction procedures was:

1. The amount of trichloroethane used in the procedure.

2. The human exposure levels to the trichloroethane in each procedure.

3. The time required to complete a test following each procedure.

4. The asphalt content determined by each procedure.

5. The aggregate gradation determined by each procedure.

The asphalt extraction procedures were done by three different laboratories on three different asphalt concrete mixes. Five samples were run on each procedure from the three different sources.

The amounts of trichloroethane used per test in milliliters is shown in Figure 1. The Vacuum procedure required the most and was followed by the Quick, Centrifuge and the Reflux procedure requiring the least. Each bar on the bar chart represents the average of 15 tests. Notice that in all figures all three labs ran the Quick, Vacuum and Centrifuge procedures and only the Headquarters Lab ran the Reflux procedure.

The trichloroethane exposure in parts per million is shown in Figure 2. The time in hours to run a test is shown in Figure 3. The Reflux procedure required the greatest time followed by the Vacuum, Quick extraction and Centrifuge taking the shortest time. The concern with time reflects the need for a field test to provide timely results. On a labor expenditure basis one person could run as many as 8-10 Reflux tests in the same time as one test given enough equipment. The time for a test as well as the amount of trichloroethane used affect the exposure levels. However, the main influence is from the ventilation system. The Quick extraction caused the greatest exposure with the Vacuum, Reflux and Centrifuge causing the least exposure. Results from District 5 are equal for all methods.

The aggregate gradation throughout the different sizes, namely the percent passing the 5/8", 1/2", 3/8", 1/4", #10, #40 and the #80, are reproducible with any of the extraction procedures.

The percent passing the #200 sieve and the percent asphalt content are areas of concern. Due to the variation in these factors between the three plants, separate plots were prepared for each source. Note in Figures 4 through 9 that the Headquarters Lab ran a continuous flow centrifuge of the liquid from each test and found 200 minus material which corrected the 200 higher and the asphalt content lower. This correction amounted to .1 percent on the Quick and Vacuum extraction procedures and .6 percent on the Centrifuge extraction.
The asphalt contents shown in Figures 10, 11 and 12 are consistent with each other for the Reflux, Quick and Vacuum extractions but the Centrifuge is .5 to .6 percent higher. The correction calculated in the preceding paragraph would bring these results in to agreement.

The percent passing the #200 sieve shown in Figures 13, 14 and 15 do not agree as well as the asphalt contents. The Quick extraction and the Vacuum extraction are consistent with each other but higher than the Reflux and Centrifuge. If the Centrifuge is corrected up by .6 percent then the Centrifuge and the Reflux would be consistent with each other but still lower than the Quick and Vacuum. Something in the two processes (Quick and Vacuum) causes the percent passing the #200 to be greater than the other two processes.

CONCLUSIONS

The Reflux extraction was included in the study as a referee basis for comparison. It is acknowledged to be too lengthy to provide timely results required under current operating procedures. The asphalt content and minus 200 values are considered as the reference levels for comparison of the other procedures.

All methods provided exposure to trichloroethane vapors well below the allowable level. The variation in exposure levels is a function of the nature of the test and the ventilation system for a particular lab.

The Reflux procedure uses the least amount of trichloroethane and exposure levels are well below the allowable (Figures 2 and 15).

The Quick extraction uses the second highest amount of trichloroethane per test (Figure 2). The time (Figure 17) is second to the lowest and acceptable for a field test. The asphalt content (Figures 10, 11 and 12) agrees quite well with the asphalt content found with the Reflux. The percent passing the #200 is about .7 percent higher (Figures 13, 14 and 15) than the Reflux.

The Vacuum procedure uses the most trichloroethane per test (Figure 16) but still has exposure levels below the allowable (Figure 2). The time required for the Vacuum is comparable with the Reflux and would not make an acceptable field test as an alternate to the Quick extraction. The asphalt content, like the Quick extraction, agrees quite well with the Reflux. The percent passing the #200 sieve is very much like the Quick extraction. It is .7 percent higher than the Reflux.

The Centrifuge procedure requires the next to lowest amount of trichloroethane per test and is well within the allowable exposure limits but does not agree with the Reflux when looking at the asphalt content or the percent passing the #200 sieve. Based on the discrepancies in minus 200 content, additional evaluations are needed to fully evaluate the differences in test procedures. These evaluations will be the subject of a supplementary report. The asphalt content and the percent passing the #200 can be corrected, when using the centrifuge extractor, by use of the complete AASHTO procedure. The AASHTO procedure captures the lost 200 minus thereby correcting both asphalt content and 200 minus. This would increase test time to a level equal to or exceeding that of the Quick extraction.

On the basis of the modified Centrifuge test procedure evaluated in this study it is not acceptable for Contract acceptance or quality assurance testing. The full Centrifuge testing procedure in AASHTO which includes a correction for the loss of fines could produce acceptable results.

FIGURES

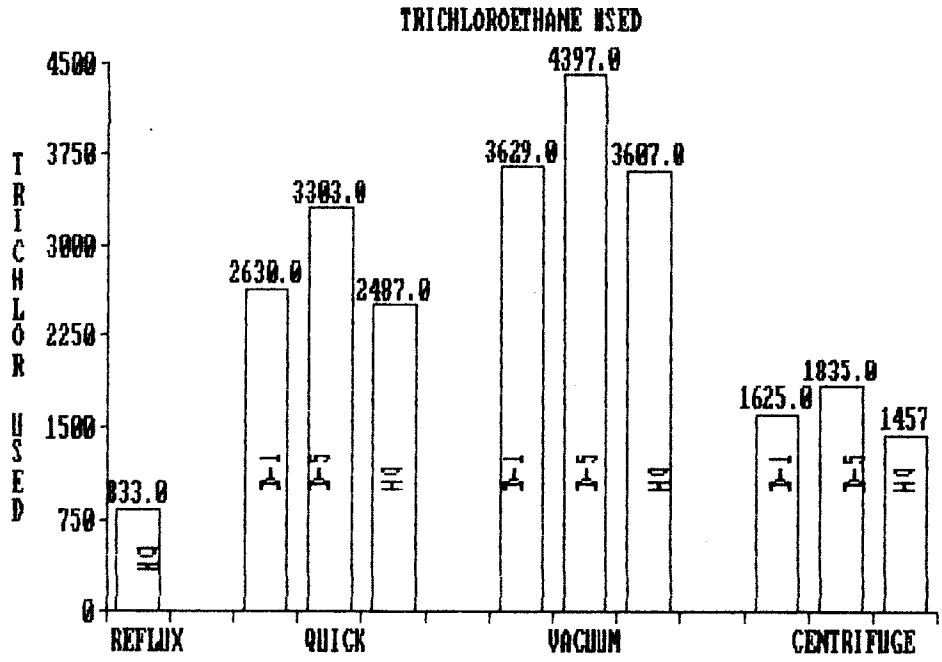

FIGURE 1. Trichloroethane used for each method of extraction.

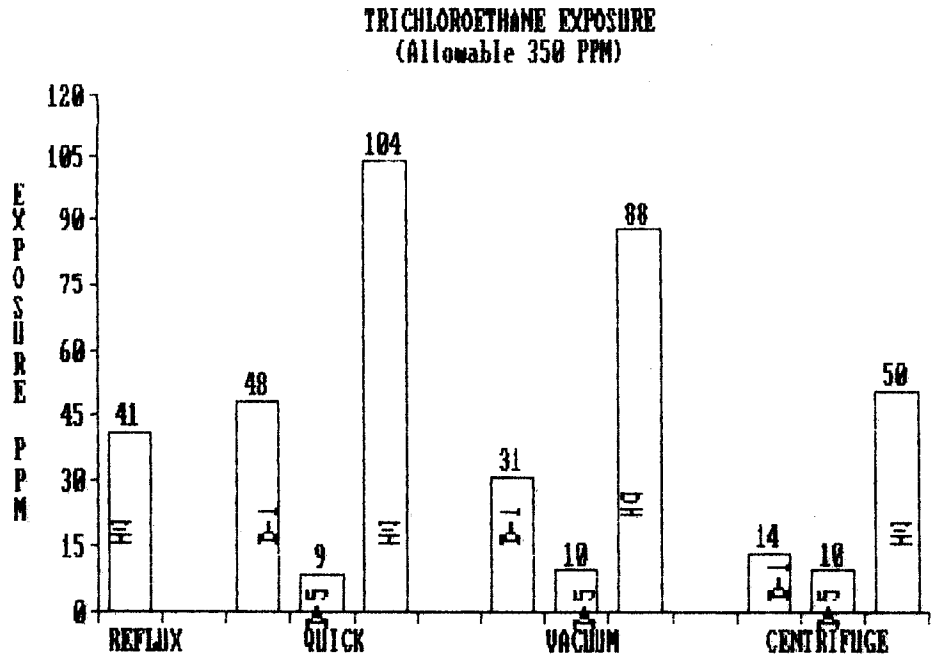

FIGURE 2. Exposure level for each method of extraction.

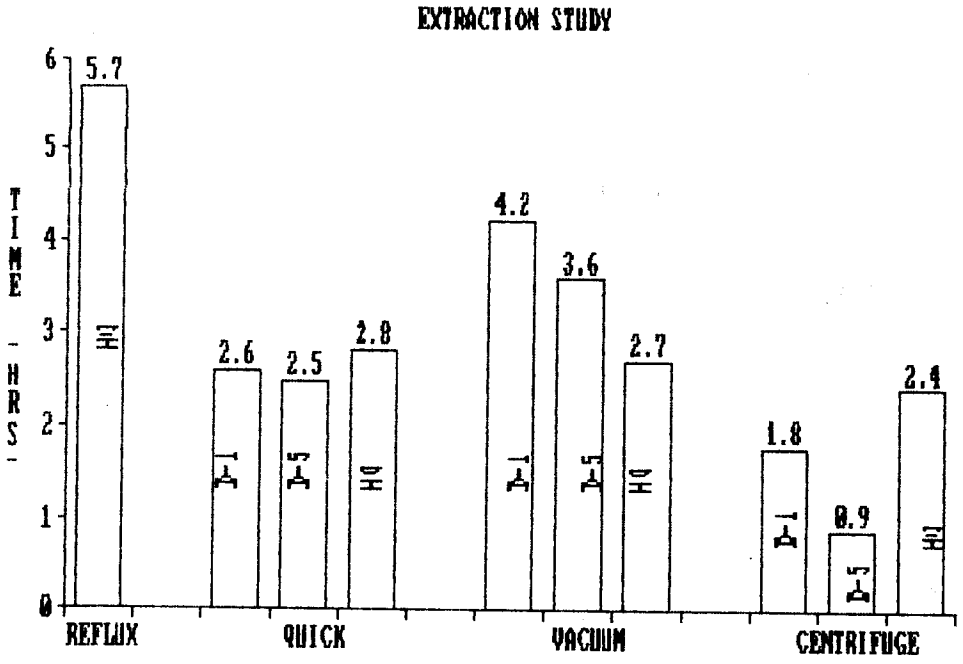

FIGURE 3. Testing time for each method of extraction.

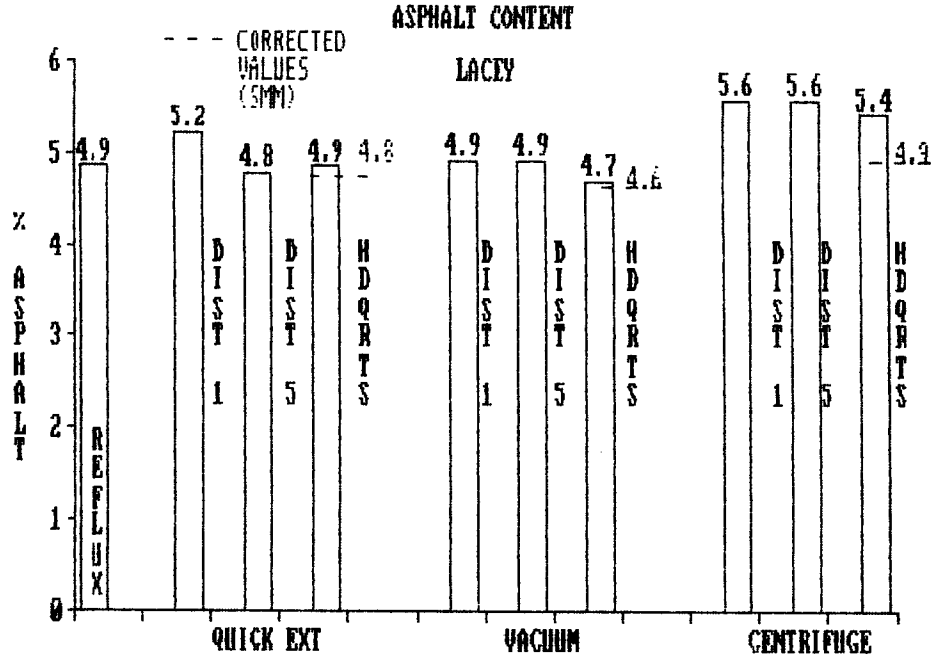

FIGURE 4. Asphalt percentages for the Lacey samples for each extraction method.

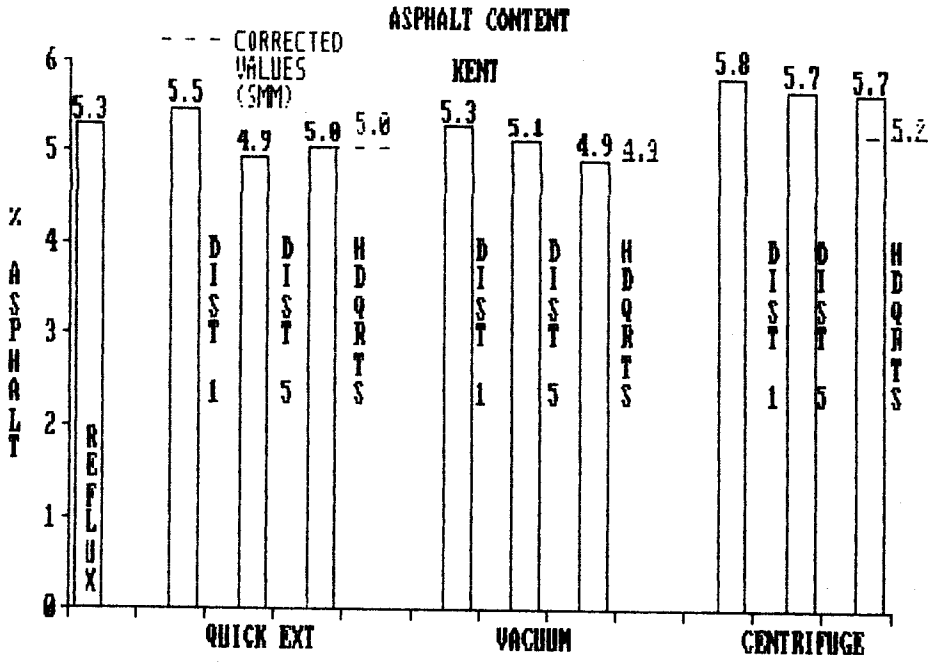

FIGURE 5. Asphalt percentages for the Kent samples for each extraction method.

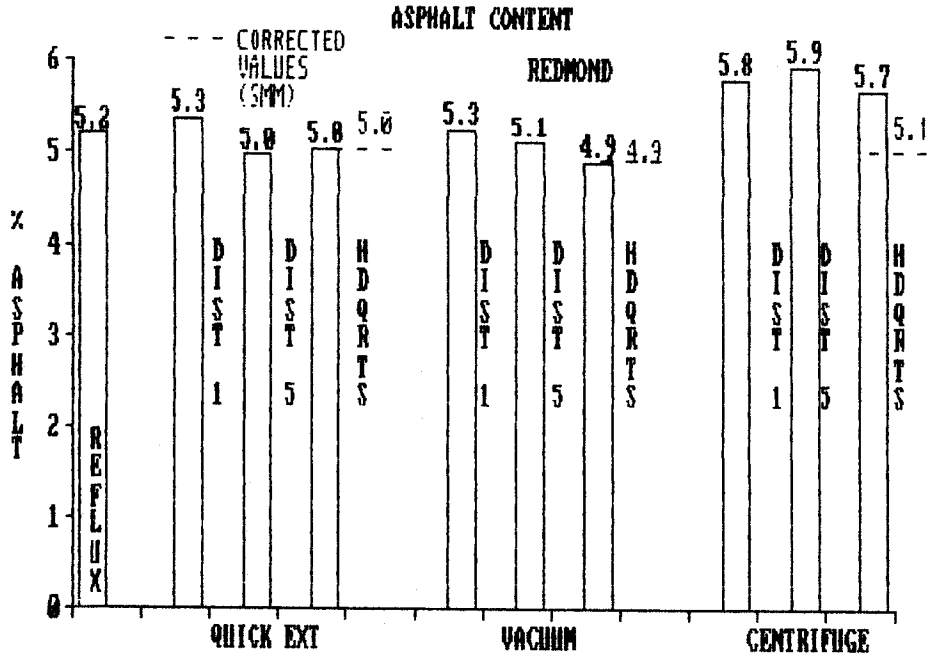

FIGURE 6. Asphalt percentages for the Redmond samples for each method of extraction.

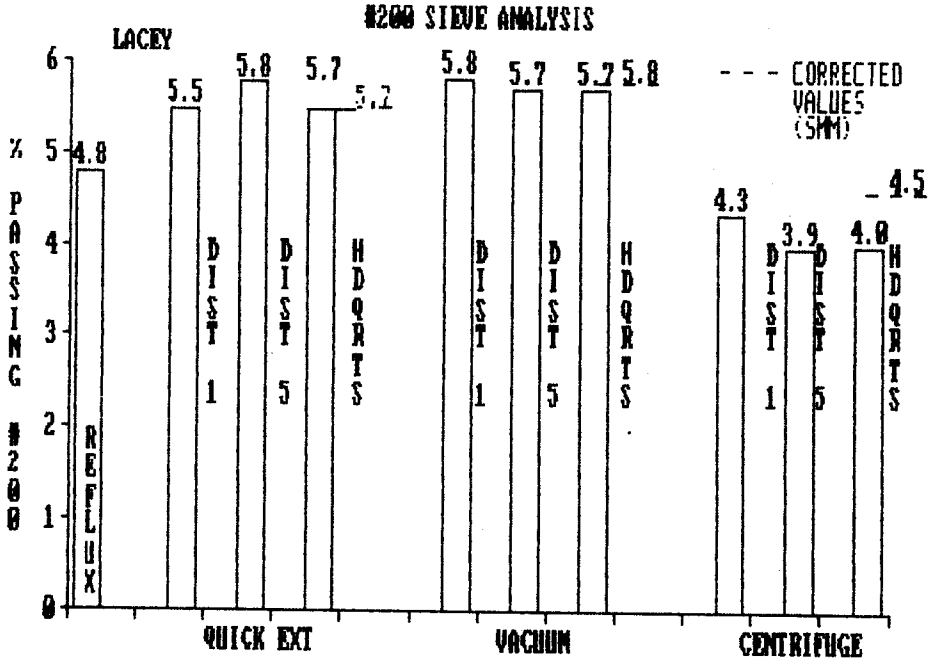

FIGURE 7. Percent passing the #200 sieve for the Lacey samples for each extraction method.

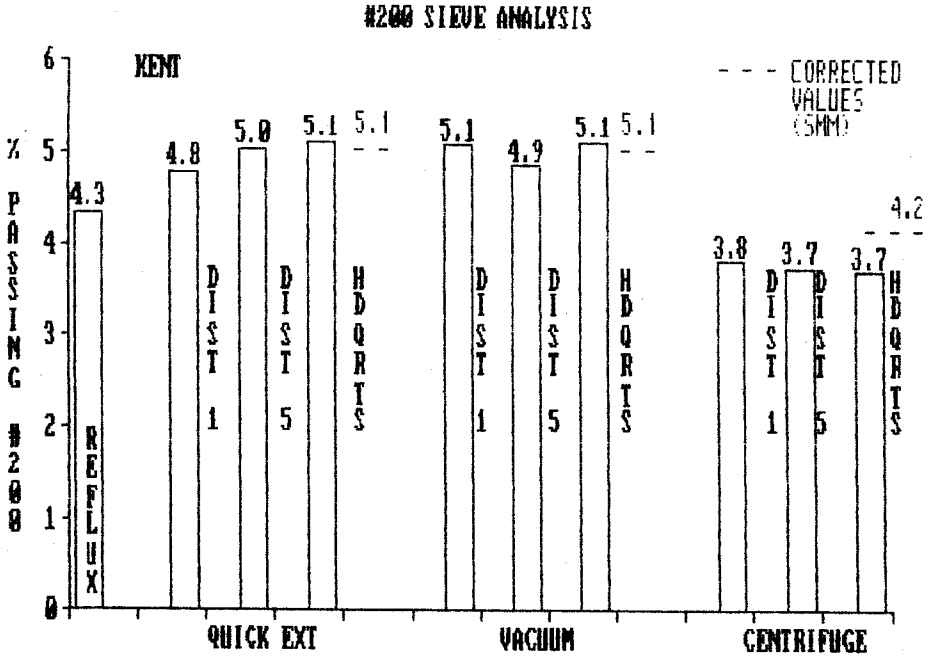

FIGURE 8. Percent passing the #200 sieve for the Kent samples for each extraction method.

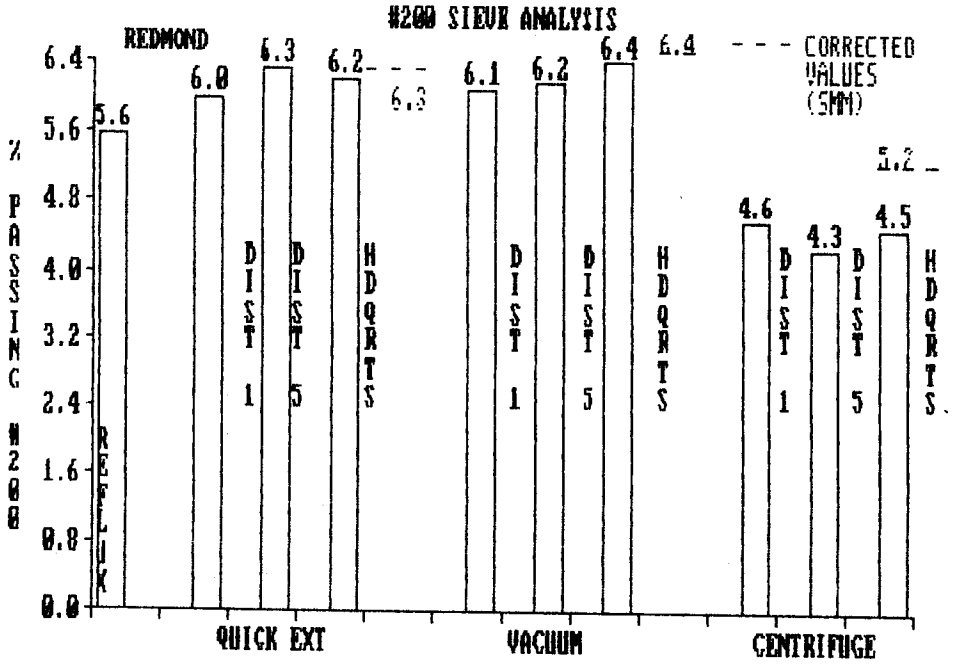

FIGURE 9. Percent passing the #200 sieve for the Redmond samples for each extraction method.

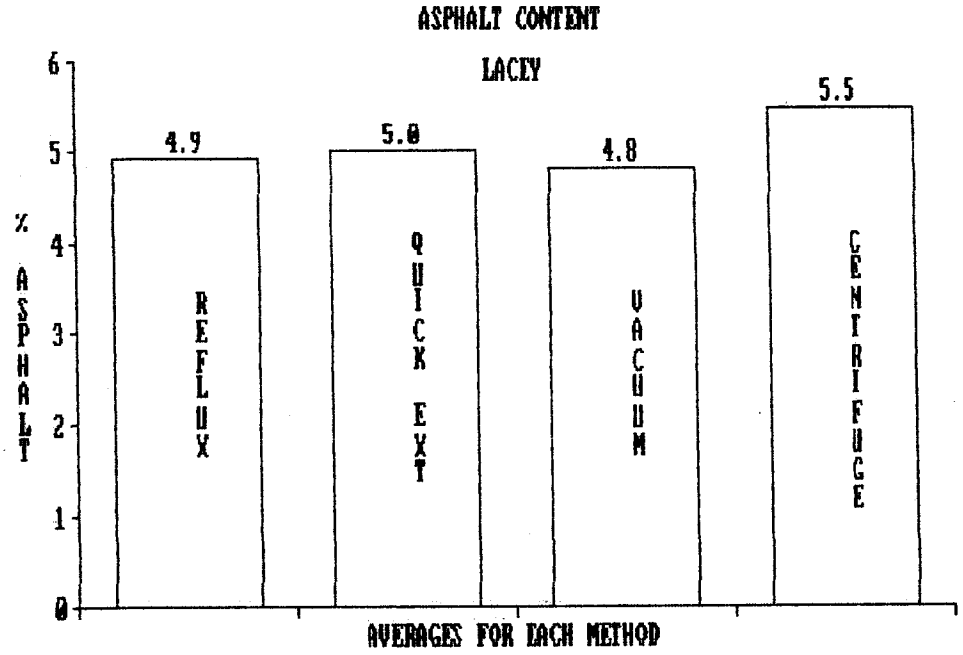

FIGURE 10. Average asphalt content for the Lacey samples for each extraction method.

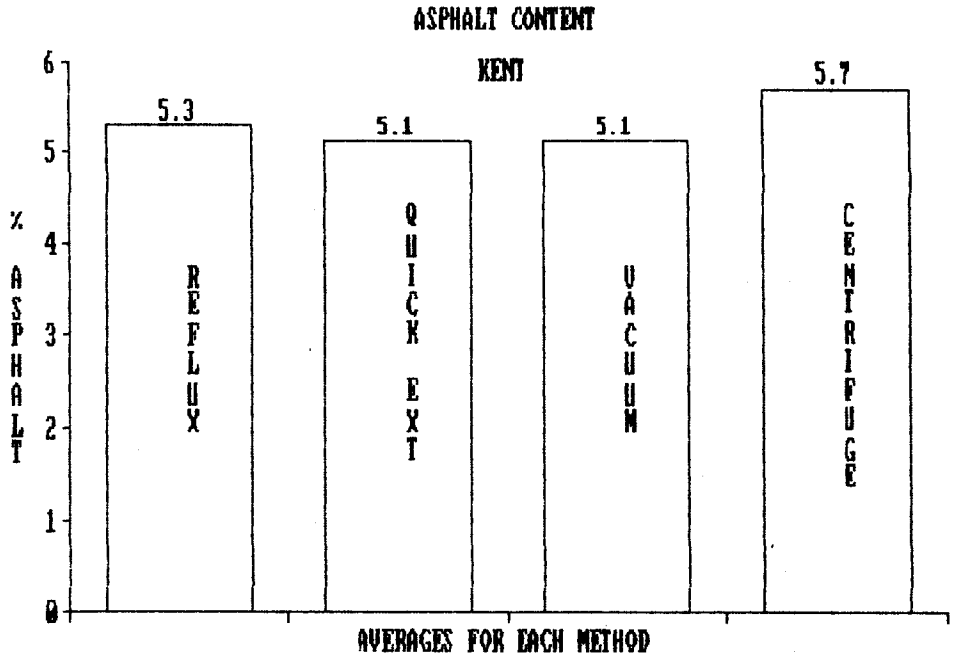

FIGURE 11. Average asphalt content for the Kent samples for each extraction method.

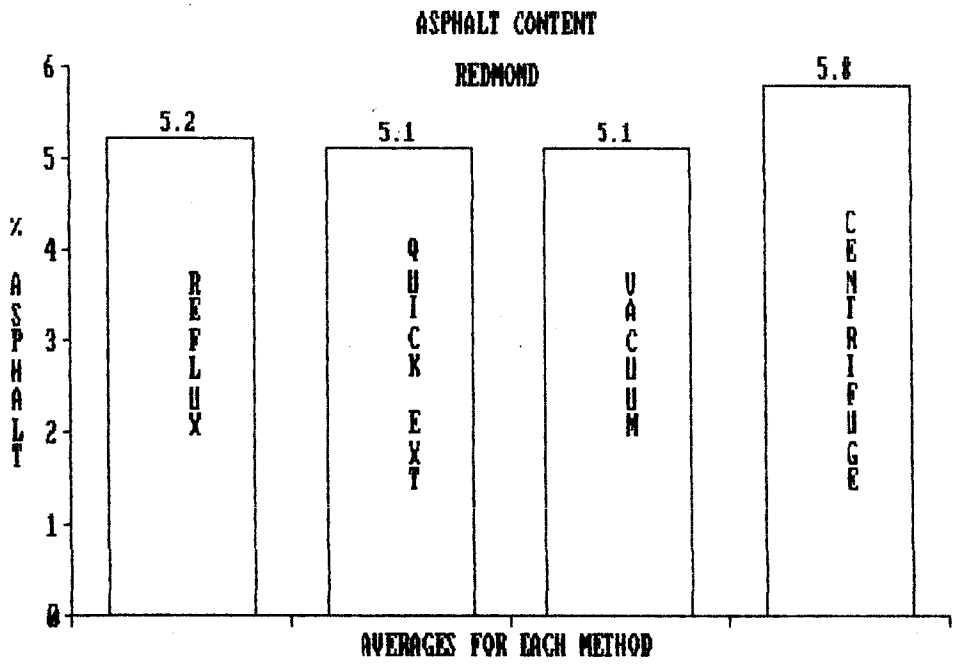

FIGURE 12. Average asphalt content for the Redmond samples for each extraction method.

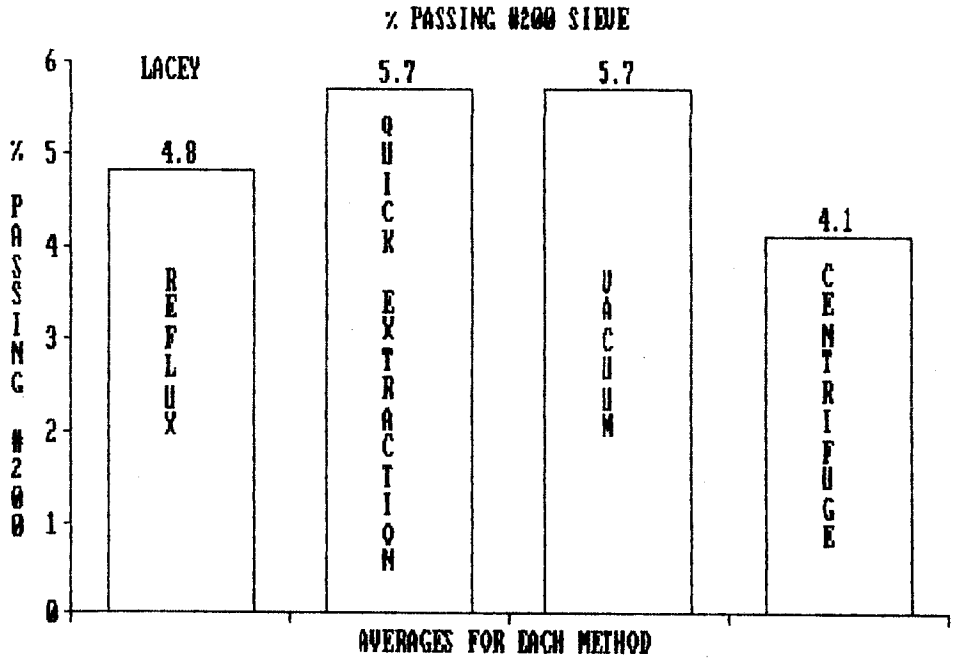

FIGURE 13. Average percent passing the #200 sieve for the Lacey samples for each extraction method.

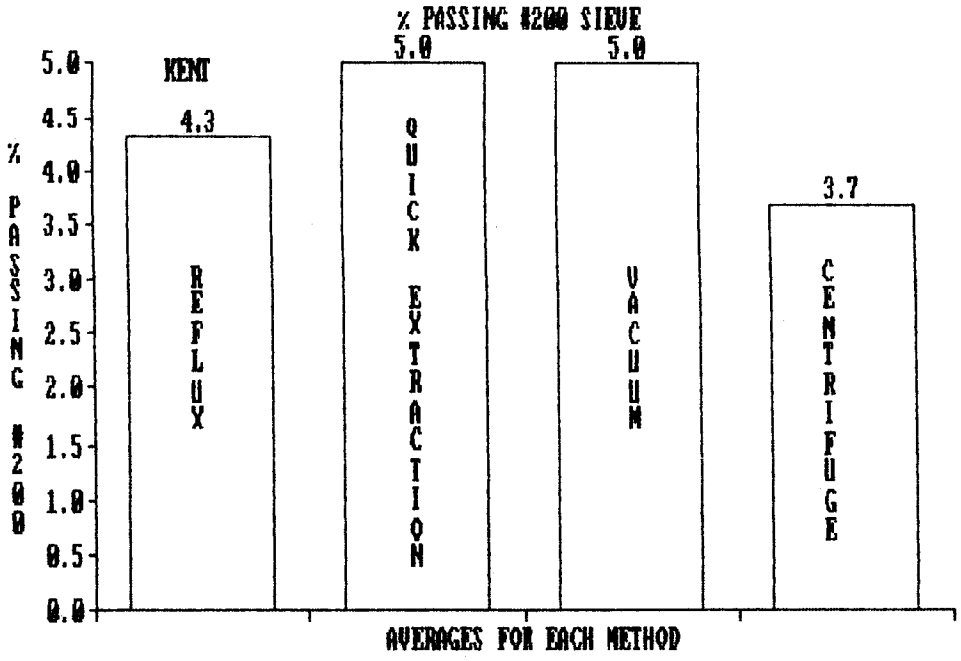

FIGURE 14. Average percent passing the #200 sieve for the Kent samples for each extraction method.

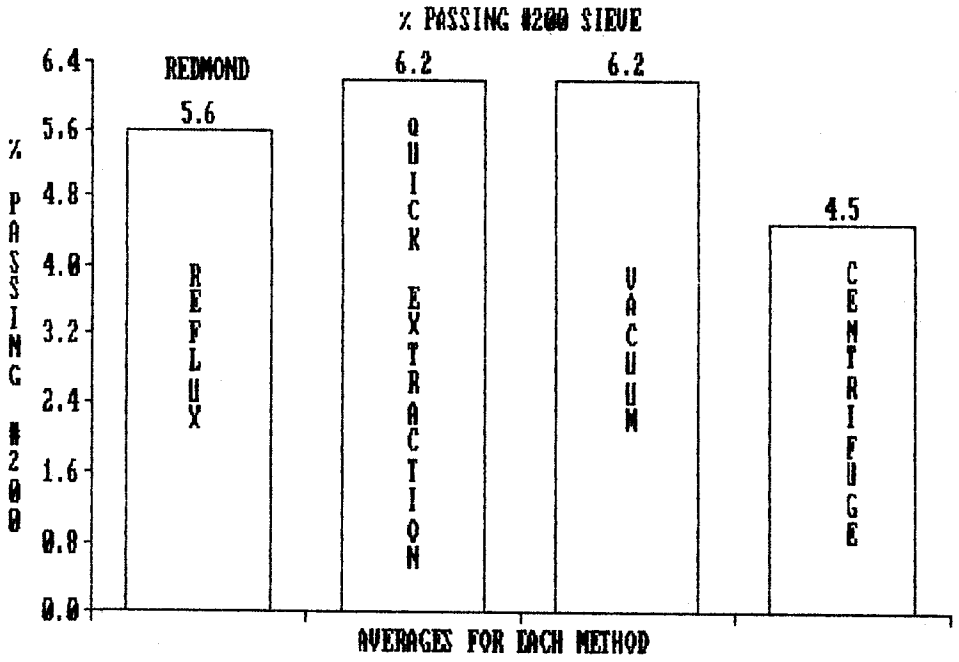

FIGURE 15. Average percent passing the #200 sieve for the Redmond samples for each extraction method.

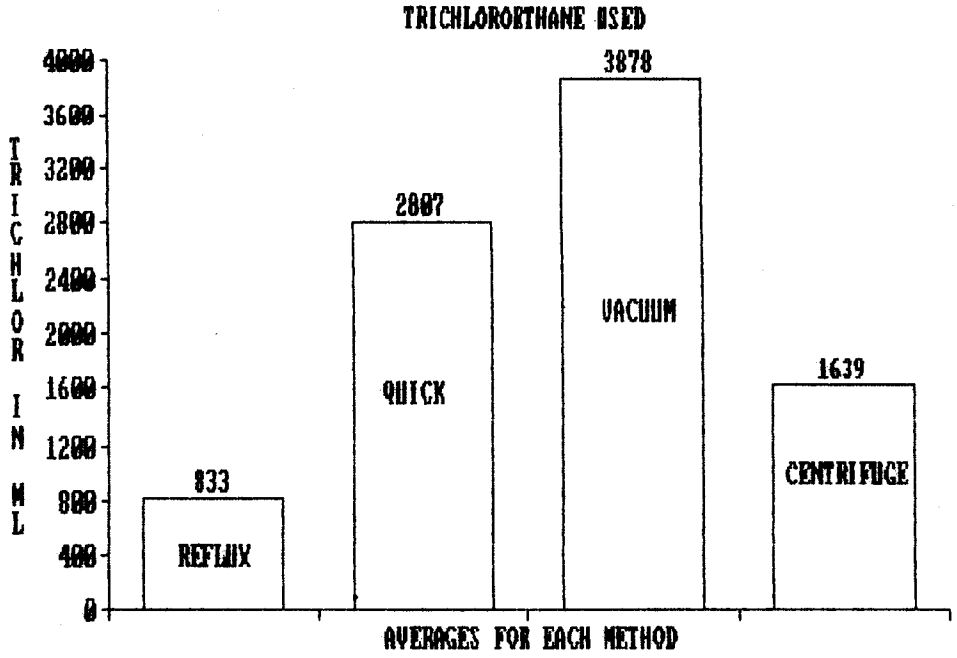

FIGURE 16. Average trichloroethane usage for each extraction method.

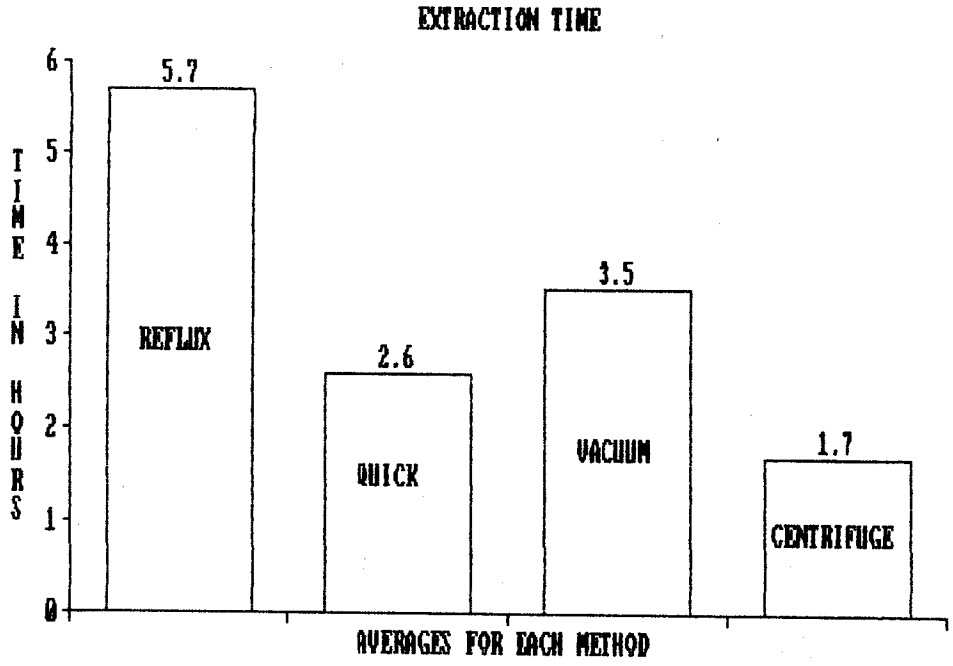

FIGURE 17. Average testing time for each method of extraction.