Work on Project 818 has included (1) tests of fuel oils, used motor oils, gas works oil, and tar oil as substitutes for road oil; (2) preparation and shipment of four 50-gallon lots of road oil sulfite waste liquor emulsion; and (3) a test of International Paper Company's Bindarene Flour as a replacement for Clarion Extract.

The tests of oils for the replacement of road oil included viscosity, emulsification, and in some cases volatile matter tests. The viscosity test was an improvised one consisting of filling a glass funnel with the test oil and noting the time required to drain. The emulsification was checked by preparing beaker-size lots of 5:1 oil-sulfite waste liquor emulsion and diluting the resulting mix in water. If no oil separated out, good emulsification was indicated. The volatile matter was checked by heating weighed samples of the oils at 95°C for several days. The results of these tests are given in Table I, next page.

The preparation of four 50-gallon drums of road oil sulfite waste liquor (5:1) emulsion was carried out on April 18 (Drum No. 1) and April 20, 1942 (Drums No. 2, 3, and 4). The materials in each lot were 14 pounds of water, 56 pounds of Clarion extract (62 per cent solids), 173 pounds of Standard Oil Company's No. 4 Road Oil, and additional water to 415 pounds total net weight. The four full drums were shipped to Chicago Waterways Fuel Company, 1110 West Division Street, Chicago, Illinois on April 21, 1942.

A test of Bindarene Flour (received from International Paper Company on May 25, 1942) was made by using it to emulsify road oil at room temperature in the following mixture:

20 grams of Bindarene Flour
20 grams of water
100 grams of No. 4 road oil
30 grams of water to thin mix while adding oil
70 grams of water to dilute to 50 per cent concentration

The emulsion was very good, a light brown colored mix which diluted to a stable cloudy brown emulsion in water.
## Tests of Various Oils

<table>
<thead>
<tr>
<th>Oil</th>
<th>Date to Drain</th>
<th>Temperature</th>
<th>Emulsion</th>
<th>Volatile Matter</th>
<th>Time Terpol.</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 4 Road Oil</td>
<td>a 237</td>
<td>a 71</td>
<td>OK</td>
<td></td>
<td>12.2</td>
</tr>
<tr>
<td></td>
<td>b 253</td>
<td>b 70</td>
<td></td>
<td></td>
<td>10.1</td>
</tr>
<tr>
<td>No. 4 Fuel Oil (1000 vis.)</td>
<td>4/17/42</td>
<td>a 266</td>
<td>a 70</td>
<td>OK</td>
<td>10.1</td>
</tr>
<tr>
<td></td>
<td>b 132</td>
<td>a 78</td>
<td></td>
<td></td>
<td>9.4</td>
</tr>
<tr>
<td>No. 4 Fuel Oil (100 vis.)</td>
<td>4/28/42</td>
<td>9.4</td>
<td>73</td>
<td>OK</td>
<td>11.6</td>
</tr>
<tr>
<td>No. 4 Fuel Oil (1000 vis.)</td>
<td>5/2/42</td>
<td>243</td>
<td>71</td>
<td>OK</td>
<td>12.2</td>
</tr>
<tr>
<td>Used No. 30 Motor Oil (Wadhams)</td>
<td>5/25/42</td>
<td>56</td>
<td>72</td>
<td>OK</td>
<td>2.9</td>
</tr>
<tr>
<td>Used Motor Oil (Sherry)</td>
<td>5/25/42</td>
<td>19</td>
<td>72</td>
<td>OK</td>
<td>2.9</td>
</tr>
<tr>
<td>Gas Works Oil</td>
<td>5/25/42</td>
<td>2</td>
<td>72</td>
<td>N.G.</td>
<td>12.2</td>
</tr>
<tr>
<td>Used Motor Oil (Wadhams)</td>
<td>5/27/42</td>
<td>27</td>
<td>72</td>
<td>OK</td>
<td>12.2</td>
</tr>
<tr>
<td>Used Motor Oil (Plymouth)</td>
<td>5/27/42</td>
<td>a 11</td>
<td>a 72</td>
<td>OK</td>
<td>18.1</td>
</tr>
<tr>
<td>Tar Oil</td>
<td>5/27/42</td>
<td>b 6*</td>
<td>b 72</td>
<td>N.G.</td>
<td>120</td>
</tr>
</tbody>
</table>

*The two different results of viscosity determinations on used motor oil (Plymouth) came from two separate samples. The latter figure is for a sample from a 30-gallon lot; the former for a sample from a 5-gallon lot.*

rew/emp
At the request of Mr. Abbott, we prepared and shipped to him four one-quart samples of oil emulsion as follows:

1. Fifty per cent 5:1 oil Clarion extract emulsion, protected against freezing with calcium chloride.

2. Ten per cent 5:1 oil Clarion extract emulsion protected against freezing with calcium chloride.

3. Fifty per cent 5:1 oil Clarion extract emulsion protected against freezing with sodium chloride.

4. Ten per cent 5:1 oil Clarion extract emulsion protected against freezing with sodium chloride.

cej/emp
Emulsion for Coal Treatment Trials at South Chicago Coal and Dock Company

In response to a request for sulfite waste liquor, Number 4 road oil emulsion for coal dusting treatments at South Chicago Coal and Dock Company, the following semicommercial preparations were shipped:

1. One hundred gallons of 50 per cent (5-1) Number 4 road oil, sulfite waste liquor emulsion with one pound of common salt (sodium chloride) added per gallon for protection from freezing. Barrels marked "A".

2. One hundred gallons of 50 per cent (5-1) Number 4 road oil, sulfite waste liquor emulsion with two pounds of calcium chloride added per gallon for protection from freezing. Barrels marked "B".

The first emulsion listed above was prepared on February 2, 1942 in two fifty-gallon lots in an open-top mixing barrel in the Institute semicommercial laboratory, using a 1 1/2 h.p. Lightning mixer for agitation. The regular order of mixing was followed. The second emulsion was prepared similarly on February 3, 1942. Samples were saved from each lot. The four barrels were shipped February 7, 1942 to R. Sherman, South Chicago Coal and Dock Company.
Sample No. 594 Re-Nu Soap submitted by Armour Soap Works has shown possibilities as an emulsifying agent for road oil. Some difficulty was previously had in dissolving the soap in cold water in the usual manner. A test was made to determine whether this soap would dissolve in cold water on standing with little agitation. Ten grams of soap were mixed with 20 cc. of water at room temperature and were allowed to stand for 2 1/2 hours. The soap dissolved completely in this period of time.

A ten to one emulsion was prepared by adding 100 grams of No. 4 road oil to the above soap solution. A small amount of oil separated from this emulsion but the soap appears to be a fairly good emulsifying agent. The emulsion diluted well with cold water.
During Dr. Kress’ recent conference with Mr. L. L. Abbott in Chicago, the question of preparing an oil emulsion that would not freeze was again brought up. Mr. Abbott stated that it was permissible to have an added cost of 3 1/2 to 5 cents per gallon of five per cent emulsion. The only possible anti-freeze agent that might work with oil soap emulsion is alcohol. Since denatured alcohol costs about 45 cents per gallon, it is out from the cost standpoint.

The solution to this problem appears to be development of an emulsion that will not break upon the addition of such materials as sodium chloride, and calcium chloride which will lower the freezing point. Sulfite waste liquor appeared to be an emulsifying agent, that is stable to electrolytes. Accordingly, the following emulsions were prepared:

1. 50 per cent (5-1) oil-not neutralized sulfite waste liquor emulsion.
2. 50 per cent (5-1) oil Clarion extract emulsion.
3. 50 per cent (10-1) oil ammonia soap ”C” emulsion.

To 40 grams of each of the above emulsions were added the following amounts of anti-freeze agents which will depress the freezing point to zero degrees F.

a. Sodium chloride 4.4 grams.
b. Calcium chloride (anhydrous) - 8 grams
c. Ethyl alcohol 11.2 cc.
d. Blank, no anti-freeze

Emulsions one and two were treated with all of the above while only c and d treatments were given to Emulsion 3. Previous tests had shown that sodium chloride and calcium chloride would cause the oil soap emulsion to separate.

The above mixtures were placed in the freezing compartments of refrigerators and were kept there over night.
The temperature and condition of the above emulsions was noted on the following date. Results were as follows:

<table>
<thead>
<tr>
<th>Sample</th>
<th>Temperature of Emulsion</th>
<th>Condition of Emulsion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-a</td>
<td>22°F</td>
<td>O.K.</td>
</tr>
<tr>
<td>1-b</td>
<td>30°F</td>
<td>O.K.</td>
</tr>
<tr>
<td>1-c</td>
<td>16°F</td>
<td>Quite viscous - O.K.</td>
</tr>
<tr>
<td>1-d</td>
<td>22°F</td>
<td>Almost solid</td>
</tr>
<tr>
<td>2-a</td>
<td>26°F</td>
<td>O.K.</td>
</tr>
<tr>
<td>2-b</td>
<td>24°F</td>
<td>O.K.</td>
</tr>
<tr>
<td>2-c</td>
<td>24°F</td>
<td>O.K.</td>
</tr>
<tr>
<td>2-d</td>
<td>22°F</td>
<td>Almost solid</td>
</tr>
<tr>
<td>3-c</td>
<td>18°F</td>
<td>Partially broke</td>
</tr>
<tr>
<td>3-d</td>
<td>--</td>
<td>Solid</td>
</tr>
</tbody>
</table>

The samples were put back in the freezing compartment of the refrigerator.

The remainder of the 50 per cent emulsions which had not been kept in the refrigerator were diluted with tap water to 5 per cent concentration. Forty cc. of the 5 per cent emulsion were then placed in two ounce bottles and various anti-freeze agents were added. The samples were then placed in the freezing compartment of the refrigerator and left there over night. The following emulsions and anti-freeze agents were used:

1-a (5-1) oil unneutralized sulfite waste liquor emulsion plus 2.4 grams of sodium chloride.
1-b (5-1) oil unneutralized sulfite waste liquor emulsion plus 10.8 grams calcium chloride.
1-c (5-1) oil unneutralized sulfite waste liquor emulsion plus 11.2 cc. ethyl alcohol.
1-d (501) oil unneutralized sulfite waste liquor emulsion - blank.

2-a (5-1) oil Clarion extract emulsion plus 2.4 grams sodium chloride.
2-b (5-1) oil Clarion extract emulsion plus 10.8 grams calcium chloride.
2-c (5-1) oil Clarion extract emulsions plus 11.2 cc. ethyl alcohol.
2-d (5-1) oil Clarion extract emulsion - blank.

3-c (10-1) oil soap emulsion plus 11.2 cc. ethyl alcohol.
3-d (10-1) oil soap emulsion - blank.
The 50 per cent emulsions which had been in the freezing compartment of the refrigerator for two days and the 5 per cent emulsion, which had been in the freezing compartment for one day were examined with the following results:

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Condition</th>
<th>Temperature</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>18° F.</td>
<td>Scur on surface but stirred in O.K.</td>
<td>18° F.</td>
<td>Layered</td>
</tr>
<tr>
<td>20° F.</td>
<td>Quite viscous - O.K.</td>
<td>13° F.</td>
<td>O.K.</td>
</tr>
<tr>
<td>16° F.</td>
<td>Almost solid</td>
<td>15° F.</td>
<td>O.K.</td>
</tr>
<tr>
<td>24° F.</td>
<td>Almost solid</td>
<td>12° F.</td>
<td>Little precipitate</td>
</tr>
<tr>
<td>20° F.</td>
<td>Almost solid</td>
<td>16° F.</td>
<td>Little precipitate</td>
</tr>
<tr>
<td>30° F.</td>
<td>Almost stiff - O.K.</td>
<td>14° F.</td>
<td>O.K.</td>
</tr>
<tr>
<td>16° F.</td>
<td>Considerable precipitate</td>
<td>12° F.</td>
<td>O.K.</td>
</tr>
<tr>
<td></td>
<td>Solid</td>
<td>10° F.</td>
<td>Solid</td>
</tr>
<tr>
<td></td>
<td>10° F.</td>
<td>10° F.</td>
<td>Solid</td>
</tr>
</tbody>
</table>

It was noted that Sample 1-a separated into two layers on standing. The top portion was brown in color while the bottom was almost colorless. The top portion seemed to dilute well with water indicating that the emulsion had not broken but rather had creamed.

The various 50 per cent and 5 per cent emulsions, which had been kept in the refrigerator were examined by diluting them with water. All samples except 3-c and 3-d seemed to be O.K., even if they had frozen. These results indicate that oil sulfate waste liquor emulsion can be protected from freezing through the use of sodium chloride or calcium chloride. Either one of these materials is cheap enough to keep the cost within Mr. Abbott's figures.

Because of the separation of Sample 1-a into two layers, a shaking test
was conducted to determine if sulfite waste liquor oil emulsion with and without sodium chloride would separate on agitation. An oil soap emulsion was also shaken simultaneously. Three 75 cc. samples of 5 per cent emulsion were shaken vigorously for one hour in a shaking machine. The following samples were used:

2-a. (5-1) oil-Clarion extract emulsion plus 15.75 grams sodium chloride.
2-d. (5-1) oil-Clarion extract emulsion - blank.
3-d. (10-1) oil-ammonia soap "C" emulsion - blank.

The samples were examined after the one hour shaking period and the data were as follows:

2-a small amount of froth but emulsion looked O.K.
2-d the sample looked the same as before shaking.
3-d emulsion had broken completely.

Samples were allowed to stand over night and were examined on the following day with results as follows:

2-a This sample had separated into two layers. The top layer, which was brown in color dispersed readily in water, indicating that the emulsion had not broken.
2-d This sample has not layered and looked O.K.
3-d This sample had separated into two layers the top layer was dark in color and appeared to be oil. It could not be dispersed in water, indicating that it had broken completely.

It was thought that Glauber's salt (Na$_2$SO$_4$·10H$_2$O) might be added to (10-1) oil soap emulsion without breaking the emulsion. A mixture of 100 cc. of 5 per cent (10-1) oil ammonia soap "C" emulsion and 12 grams of Glauber's salt was prepared. The emulsion broke in a relatively short time and separated into two layers. The broken emulsion was placed in the freezing compartment of the refrigerator to see if it would freeze solid. This mixture will be examined at a later date.
We have received various samples of soap which have been tried out as emulsifying agents for $\frac{1}{4}$ road oil. In general, the procedure was to add 10 grams of soap to 30 grams of water at room temperature and stir this until the soap was completely dissolved. We then added 100 grams of $\frac{1}{4}$ road oil, and each mixture was stirred for 5 minutes after the addition of the oil. The emulsion was then diluted to 50 per cent by the addition of 50 cc. of water.

The following soaps were received and were tested as emulsifying agents:

1. **Brag Soap.**
   
   This is a Procter and Gamble product, 45 per cent dry, and sells for $0.08 per pound.

2. **American Crown Soap.**
   
   This is a Procter and Gamble product, 65 per cent dry, and sells for $0.1075 per pound.

3. **Grade B Mahogany Soap (from Tank $16$, T-$1937$).**
   
   This is a product of the Standard Oil Company of Indiana and sells for $0.06$ to $0.07$ per pound.

4. **Sodium Soap TR.**
   
   This is a product of the Harshaw Chemical Company. No price was given.

5. **Sodium Soap TC.**
   
   This is a product of the Harshaw Chemical Company. No price was given.

These products were tested from the standpoint of soap solubility and emulsion stability. The following results were obtained:
(1) Brag Soap.

This product was found to have fairly rapid solubility in cold water. The 50 per cent emulsion was dark brown in color and broke considerably on dilution to 5 per cent.

(2) American Crown Soap.

This soap was very slowly soluble in cold water, and for this reason it was necessary to dissolve it in warm water. The 50 per cent emulsion was brown in color and separated a little when diluted to 5 per cent.

(3) Grade B Mahogany Soap.

This soap dissolved very readily in cold water. The 50 per cent emulsion was black in color and appeared to separate almost completely. The emulsion separated further on dilution to 5 per cent.

(4) Sodium Soap TB.

This soap dissolved readily in cold water. The 50 per cent emulsion was brown in color and showed very little separation on dilution to 5 per cent.

(5) Sodium Soap TC.

This soap dissolved readily in cold water. The 50 per cent emulsion was brown in color and showed very little separation on dilution to 5 per cent.

These results indicated that Sodium Soap TB and Sodium Soap TC were the only ones of the above tested soaps which would be as satisfactory as Ammonia Soap "C0 for emulsifying #4 road oil. The American Crown Soap produced a stable emulsion but requires warm water for solution. The Brag Soap and Grade B Mahogany Soap gave very inferior emulsions.
As a result of Dr. Kress's inquiry for a cheap soap, Armour Soap Works submitted a sample of no. 594 Re-Nu soap. Their current price for this soap is $5 3/4 cents per pound, f.o.b. factory. The soap is dark in color and it has a tarlike odor.

This soap was not readily soluble in cold water; therefore, it was dissolved in hot water, using 10 cc. water per 10 g. of soap. Ten cc. additional water was added to this mixture after which 100 g. of no. 4 road oil were added. The resulting emulsion appeared stable and could be diluted satisfactorily to 5 per cent.

These results indicate that this soap is satisfactory for preparing a 10 to 1 oil soap emulsion.
During Dr. Kress's recent conference with Mr. Abbott, the question of odor developing from the soap used for treating coal was brought up. In order to determine if the soap in a 10-1 oil-soap emulsion used for dedusting coal will turn rancid, three gallons of 3 per cent of 10-1 emulsion were applied to coal in Institute coal bin. Approximately 9 sq. ft. of coal surface were treated with the emulsion. The emulsion treated coal was then covered up so that it would not dry too rapidly. This coal will be allowed to stand for some time and will be examined periodically for odor.

Experiments were conducted to emulsify oil with gum rosin dissolved in soda ash and sodium hydroxide. In one case, gum rosin was cut with 20 per cent soda ash and in the other case with 15 per cent sodium hydroxide. Ten parts of No. 4 road oil were then added to 1 part of the sodium soap. Some difficulty was had in producing a soap that could be diluted rapidly with water. It was found that the water had to be added slowly to the soap. The oil-soap emulsions appeared satisfactory when first prepared. However, when they stood overnight, they separated into two layers. After the samples had stood a week, the emulsion prepared from gum rosin dissolved in soda ash was dark in color while the emulsion prepared from gum rosin dissolved with sodium hydroxide was light brown in color. As a general rule, the lighter the emulsion is in color, the more satisfactory it is.

It had been suggested that sodium chloride be used with the emulsion to lower its freezing point. Experiments were conducted adding sodium chloride to 50 per cent and 3 per cent 10-1 oil-soap emulsions. Two and a half grams of sodium chloride were used with 25 grams of emulsion on the wet basis. The emulsions containing sodium chloride as well as those with no sodium chloride were placed in the freezing compartment of the refrigerator for a couple of hours. They were then taken out and were examined for rigidity. The three per cent emulsions with and without the sodium chloride had frozen rigidly. The 50 per cent emulsion with sodium chloride was quite soft while the 50 per cent emulsion without sodium chloride was considerably harder.

The emulsions were allowed to thaw out and were examined again. None of the emulsions were satisfactory. The 50 per cent emulsion without sodium chloride seemed to dilute best in water.

Colgate-Palmolive Feet Company submitted three samples of soap to be used as emulsifying agents. These were as follows:
1. Colgate formula 25 soap flakes
2. Peet yellow laundry bar soap
3. Mahogany laundry bar soap

It was necessary to dissolve samples 2 and 3 in hot water. Emulsions were prepared from these soaps, adding 100 grams of No. 4 road oil to each of the following:

1. 2 grams of formula 25
2. 5 grams Peet yellow
3. 5 grams mahogany

None of these soaps were satisfactory in the quantity used since oil separated out of each of the emulsions. The above small amounts of soap were used because Colgate-Palmolive Peet Company representative who visited the Institute recently stated that these soaps would be effective in small quantities. It was thought we could cheapen the soap cost by using one of their soaps but using a smaller amount of it.

The above three Colgate-Palmolive Peet Company soaps were tried out as emulsifying agents, using 1 part of soap to 10 parts of No. 4 oil. The emulsion made from mahogany laundry bar soap separated on dilution. The emulsions prepared from the other two soaps appeared to be fairly stable but show no advantage over ammonia soap.

Ediphone cej/rvd
We prepared two 50 gallon drums of 50 per cent 10 to 1 No. 4 road oil ammonia soap "c" emulsion at the request of Mr. W. L. Abbott. This emulsion will be shipped to Mr. Ralph Sherman of South Chicago Coal and Dock Company about October 8, 1941.

In preparing the first batch of emulsion, approximately 90 pounds of water was used with the soap in order to thin it out sufficiently so that it could be stirred. This batch of emulsion did not appear to be particularly stable. In preparing the second batch of emulsion, 60 pounds of water was used with the same amount of soap as in the previous batch. This produced a very satisfactory emulsion, the only difference, that was noted in the preparation of these two emulsions was that in the second case the emulsifier was left contaminated with the previous emulsion. Apparently, the oil left in the drum reduced the foaming tendency of the soap sufficiently so that a smaller amount of water could be used.

Dictaphone cj/wm
Three 50 gallon batches of 50% 10-1 oil-soap emulsion were prepared using the following ingredients per batch.

- 50 pounds of water
- 15.9 pounds ammonia soap "C"
- 129 pounds number 4 asphalt road oil from Standard Oil Company
  Diluted to 415 pounds or 50 per cent.

The three drums of 50 per cent 10-1 oil-soap emulsion were shipped to Mr. Ralph Sherman, South Chicago Coal and Dock Company, Chicago, Illinois. They represent the first three drums of our 20 drum order which will be shipped to Mr. Sherman, within the next two weeks.

On September 16, three fifty gallon drums of 50% 10-1 oil-soap emulsion were prepared and shipped by Olson Transfer Truck to Mr. Ralph Sherman of the South Chicago Coal and Dock Company, Chicago, Illinois.

On September 17 and 13, four 50 gallon batches of 50% 10-1 number 4 oil-ammonia soap "C" emulsion were prepared and were shipped on September 18 to Mr. Ralph Sherman of South Chicago Coal and Dock Company, Chicago, Illinois.

On September 19, four more batches of 50 gallons each of 50% 10-1 number 4 road oil-ammonia soap "C" emulsion were prepared. These represent batches 11, 12, 13, and 14 of the 20 drum shipment to go to Mr. Sherman. These four drums will be shipped on Monday, September 22.
As a result of my discussion with Mr. W. L. Abbot on September 3, the following emulsions were prepared and tested for stability to dilution and shaking:

1. Fifty per cent (10-1) oil ammonia soap "C" emulsion.
2. Fifty per cent (15-1) oil ammonia soap "C" emulsion.
3. Fifty per cent (20-1) oil ammonia soap "C" emulsion.
4. Same as 3, except kept temperature at 50 C. instead of room temperature.

The above emulsions were examined after they had stood for a while with the following results:

1. No separation of oil.
2. Slight separation of oil.
3. Considerable separation of oil.
4. Considerable separation of oil.

Ten cc. of each emulsion was diluted with 90 cc. of water and placed in 5 ounce bottles. The samples were then shaken vigorously, for 35 minutes on shaking machine, they were then examined with the following results:

1. Slight separation of oil.
2. Very considerable separation of oil.
3. Very considerable separation of oil.
4. Slight separation of oil.

These results indicate that a 10-1 emulsion prepared at room temperature is quite satisfactory.

Prepared 54 gallons of 10-1 No. 4 road oil ammonia soap "C" emulsion and shipped 50 gallons of this to Mr. Sherman of South Chicago Coal and Dock Company. Four gallons of the emulsion were shipped to Mr. W. L. Abbot, 20 North Wacker Drive, Chicago, Illinois.
According to Mr. W. L. Abbot's request, the following emulsion was shipped to Mr. Ralph A. Sherman, Supervisor, Fuels Division, Battelle Memorial Institute, Columbus, Ohio:

573 cc. water
191 grams ammonia soap "C"
3809 Grams No. 4 road oil
Added 3427 cc. water to give 50 per cent emulsion.

Dictaphone caj/mjh
At the request of Mr. W. L. Abbot, five fifty gallon batches of 50 per cent (20-1) No. 4 asphalt road oil ammonia soap "C" emulsion were prepared and shipped to Mr. Ralph Sersan, South Chicago Coal and Dock Company, 3434 East 95th Street, Chicago, Illinois. The following materials were used per batch of emulsion:

- 45 lb. water
- 9.9 lb. ammonia soap "C"
- 138 lb. No. 4 road oil (Standard Oil Company)

Diluted to 415 lb. or 50 gallons.

Small samples of the above emulsions were examined by dilution with water. All samples appeared quite satisfactory, and diluted well with water.

Dictaphone cej/mjh
Visited Kimberly-Clark Corporation and discussed with Mr. Jack Girard the problem of coal dusting. Small piles of coal, which were treated on June 8, were examined. Pile No. 2 looked the best and was still wet at the bottom. Pile No. 1 also looked good.

It was decided that Mr. Girard will send 50 gallons of their coal spray oil to the Institute, which we will emulsify and will then ship back to Kimberly. This emulsion will then be tried out for dusting experiments.

Two fifty gallon batches of (20-1) K. C. coal oil, cotton seed soap emulsion were prepared and were picked up by the Kimberly-Clark Corporation. These emulsions will be used for coal dusting experiments when it is convenient for Kimberly-Clark Corporation.

Determined the relative viscosities of the above 50 per cent emulsion, the above emulsion diluted to 20 per cent and tap water. The data were as follows:

<table>
<thead>
<tr>
<th>Sample</th>
<th>Temperature ° C</th>
<th>Time to Drain 10 cc</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 % E.</td>
<td>29</td>
<td>74 sec.</td>
</tr>
<tr>
<td>20 % E.</td>
<td>28</td>
<td>17</td>
</tr>
<tr>
<td>Water</td>
<td>27</td>
<td>15</td>
</tr>
</tbody>
</table>

Dictaphone cej/mjh
The following emulsions were tried out for wetting of coal with results as indicated:

1. One cc. water, no penetration.
2. 0.2 per cent NaOH 1 cc., no penetration.
3. 0.2 per cent Aerosol - 1 cc., some penetration.
4. 10 per cent Aerosol - 4 cc., very good penetration.
5. 0.4 per cent Aerosol - 4 cc., good penetration to 3/16 of an inch depth.
6. Ten per cent Thilmany black liquor soap, very good penetration.
7. 0.4 per cent Thilmany black liquor soap, good penetration, to 1/16 inch depth.
8. 0.8 per cent Thilmany black liquor soap, very good penetration.
9. Ten per cent (20-1) No. 4 oil ammonia soap "C" plus 0.8 per cent Thilmany black liquor soap, very good penetration.
10. Ten per cent (20-1) No. 4 oil-ammonia soap "C" emulsion, no penetration.
11. Twenty per cent (5-1) No. 4 oil - cotton seed soap emulsion, very good penetration.
12. Ten per cent (5-1) No. 4 oil - cotton seed soap emulsion, good penetration.
13. Five per cent (5-1) No. 4 oil - cotton seed soap emulsion, which penetrates to about 1/4 inch depth.
14. Twenty per cent (20-1) Texas Company Hydra oil ammonia soap "C" emulsion, no penetration.
15. Twenty per cent (20-1) Texas Company Rabtex oil - ammonia soap "C" emulsion, no penetration.

Examined the four small piles of coal at Kimberly-Clark Corporation on June 24. All samples were in good shape. Water was poured over each pile and no dissolved material could be detected.

Prepared a gallon of (10-1) No. 4 fuel oil cotton seed soap emulsion and applied it to coal on barge at Kimberly-Clark Corporation. The emulsion seemed to penetrate the coal quite well. Prepared and shipped two gallons of (1-1) sulfite waste liquor No. 4 road oil emulsion to Mr. W. L. Abbot, Chicago, Illinois. The emulsion was prepared from dry sulfite waste liquor with lime neutralized.

Dictaphone caj/mjh
The following emulsions were prepared to be used for small scale coal dusting trials at Kimberly-Clark Corporation, Kimberly, Wisconsin.

1. Fifty per cent oil waste sulfite liquor kraft soap emulsion. 1430 grams No. 4 fuel oil, 500 grams dry sulfite waste liquor, 300 cc. of water, 72 grams of kraft soap from Thilmany, diluted to 4000 grams or 50 per cent.

2. Fifty per cent (20-1) oil ammonia soap "C" emulsion.

3. Fifty per cent (3-1) oil sulfite waste liquor emulsion.

4. Twenty per cent No. 3 emulsion with 50 grams of lime per 1600 grams No. 3 emulsion.

In collaboration with Mr. Paul Kuhnel of Kimberly-Clark Corporation, the previous emulsions were used to treat coal piles of about twenty pounds each. None of the emulsions went into coal very well, but No. 2 was definitely the best and No. 1, next best. The No. 2 emulsion seemed to soak into the coal when a cavity was made in the coal pile. A large excess of concentrated emulsion was poured on these coal piles and will be allowed to dry, after which the piles will be examined for dusting characteristics.

Ten gallons 50 per cent (20-1) No. 4 roe oil, ammonia soap "C" emulsion were prepared and shipped to Mr. Ralph Sherman, South Chicago Coal and Dock Company, 3434 East 95th Street; Chicago, Illinois.

Dictaphone cej/mjh
One gallon of 50 per cent (10 - 1) #4 road oil - ammonia Soap "C" was prepared and shipped by parcel post to Mr. W. L. Abbott, 20 North Wacker Drive, Chicago, Illinois.

Mr. W. L. Lundy, Paul Kuhnel, and Kenneth Wink, engineers of Kimberly-Clark Corporation visited the Institute this morning at the request of Dr. Kress. Their problem of coal dusting was discussed and they were definitely interested in improving their present method of dusting coal.

Kimberly-Clark representatives stated that they treat their coal for two reasons:

1. To prevent the dust from getting in on the paper machine
2. To keep the coal dust out of the nearby homes

Kimberly-Clark Corporation purchases coal pretreated with oil. However, they give this coal an additional treatment after it is stored in piles. This treatment, known as "capping," consists of spraying the top of the coal pile with #4 fuel oil of viscosity of 1000. This "capping" process has been patented by a coal dealer at Marinette, Wisconsin.
The briquettes of coal which were treated on May 17 to prevent dusting were tested by rubbing the coal against the palm of the hand and noting the amount of dust that came off. Only samples 1A and 1B were satisfactory. Very little dust could be rubbed off these samples.

Asphalt briqueted coal samples submitted by Mr. W. L. Abbott were treated with the following emulsions to prevent dust:

1. 8 to 1 wax ammonia soap "C" emulsion
2. 3 to 1 wax sulfite waste liquor emulsion
3. 3 to 1 wax protein emulsion

Briquettes were treated by immersing them in 5 per cent emulsion for 10 seconds at room temperature. The samples were allowed to air dry.

On testing the samples on the following day, it was found that sample No. 3 was slightly better than the other two while sample No. 1 was next best. However, there was not a great deal of difference in them.

Small pieces of coal were treated in the following saturated solutions of dyestuffs in an attempt to color the coal.

1. Sky blue 5BX
2. Alizarine saphirrole
3. Methylene blue ZX
4. Crocin scarlet
5. Purpurine LB
6. Victoria green

After the samples were air dried, they were examined for depth of color. None of the dyes produced deep colors but they all gave the coal a slight tinge of the color used.

The following emulsions and solutions were prepared for coal dedusting experiments:

1. 10 per cent (10 - 1) #4 road oil - Gaylord Soap
2. (3 - 1) #4 road oil - sulfite waste liquor emulsion
2A. 2 cc. 10 per cent NaOH added to 100 cc. 5 per cent #2 emulsion
2B. 0.1 g. ultrawet added to 100 cc. 5 per cent #2 emulsion
3. Gaylord Soap solution
3A. Diluted 3 from 5 per cent to 1 per cent
Small pieces of asphalt briquetted coal were treated in the above emulsions or solutions. It was noted that the coal wetted quite well in some of the samples while it did not wet the other. The coal did not wet well in Sample 2. It wetted a little better in Sample 2A and slightly better in 2B. The coal wetted well in sample 1 and very well in sample 3 and 3A.

After the coal had been allowed to air dry, it was examined for dusting. All samples were quite free of dust but sample 1 appeared to be best.

Experiments were conducted to determine the amount of emulsion solids picked up by coal. The experiments were conducted with 5 per cent and 10 per cent (10 - 1) #4 road oil yielded soap emulsion. The coal briquets were weighed before and directly after dipping in the emulsion for about 10 seconds at 25° C. The amount of emulsion solids picked up by the 5 per cent and 10 per cent emulsions were as follows:

For the 5 per cent emulsion - 0.65 lb. emulsion solids per ton of coal
For the 10 per cent emulsion - 2.8 lb. emulsion solids per ton of coal

The effect of time on the amount of emulsion absorbed by coal was determined. Ten per cent oil soap emulsion was used at 25° C. The coal samples were immersed in the emulsion and a gain in weight was noted for various time intervals. The following table gives the various data:

<table>
<thead>
<tr>
<th>Dipping Time</th>
<th>Gain in Weight</th>
<th>Pounds of Emulsion Solids per ton of coal</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 sec.</td>
<td>9.2</td>
<td>4.45</td>
</tr>
<tr>
<td>5 min.</td>
<td>26.7</td>
<td>12.9</td>
</tr>
<tr>
<td>110 min.</td>
<td>32.2</td>
<td>15.5</td>
</tr>
</tbody>
</table>

These results indicate that coal picks up almost as much emulsion in 5 minutes as in 110 minutes.
At the request of Mr. W. L. Abbott of Chicago, Illinois, the following emulsions were prepared for coal deducting experiments to be made by Mr. Abbott:

1. 75 per cent (20 to 1) coal oil - soap "C" emulsion
   265 g. ammonia soap "C"
   307 g. water
   5330 g. Badger Coal Spray Oil Lite
   1074 cc. water added for 75 per cent emulsion.

2. 75 per cent (20 to 1) asphalt road oil - soap "C" emulsion
   269 g. ammonia soap "C"
   307 g. water
   5330 g. #4 asphalt road oil
   1074 cc. water added for 75 per cent emulsion.

3. 50 per cent (3 to 1) oil - sulfite waste liquor emulsion
   941 g. sulfite waste liquor
   2323 g. oil, consisting of 1412 g. #7 road oil and 1412 g.
   Badger Coal Spray Oil Lite
   2823 cc. water added for 50 per cent emulsion.

The following emulsions were prepared to be used for treating 1-inch cubes of coal submitted by Mr. W. L. Abbott of Chicago:

1A. Regular 10 per cent (3 to 1) wax protein emulsion
1B. Regular 10 per cent (3 to 1) wax protein emulsion + 0.5 g. Cardinol per 400 cc. emulsion
2A. 10 per cent (20 to 1) Badger Coal Spray Oil soap emulsion
2B. Same as 2A, except added 0.5 g. Cardinol per 400 cc. emulsion
3A. 10 per cent (3 to 1) Badger Coal Spray Oil - waste sulfite liquid
3B. Same as 3A, except added 0.5 g. Cardinol per 400 cc. emulsion

Small pieces of coal were treated by dipping for several minutes in the various emulsions. They were then allowed to air dry and were tested at a later date.

Ediphone ccj/rvd
A 20 to 1 oil soap emulsion was prepared using the following materials:

60 cc. water at 25° C.
25 g. ammonia soap "C"
400 g. Badger Coal Spray Oil Lite
40 cc. water was added to give a 75 per cent emulsion

The emulsion appeared to be fairly stable and could be diluted satisfactorily to 10 per cent.
Mr. W. L. Abbott of Chicago, Illinois suggested the use of Institute wax emulsion for dedusting coal. At present oil is used largely for this purpose at a cost of about 5 to 10 cents per ton of coal. The oil is sprayed at a pressure of 250 pounds per square inch.

Because of the low permissible cost, it was thought that wax protein emulsion would be too costly. From a cost standpoint, the logical material used would be road oil emulsified with a small amount of any suitable cheap emulsifying agent.