A mixture of, essentially, polymerized olefins and diolefins is obtained as a by-product in the refining of highly cracked gasoline distillates. It is used as a substitute for linseed and other drying oils. The properties are as follows: specific gravity, 0.956; viscosity (Saybolt Universal at 100° F., or 37.8° C.), 200 seconds; and iodine number, 173 (*2*).

Uses for Cracked Gases

Cracked gases now form the basis of a synthetic chemical industry wherein a large number of compounds, having a wide variety of uses, are produced.

Chemically, the unsaturated hydrocarbons in cracked gases react readily to form many compounds useful as such, or as intermediates for making other products. The chlorides, such as ethylene dichloride, may be made without difficulty by simple addition. Hypochlorous acid reacts readily with olefins to form chlorohydrins which can be subsequently converted into glycols by hydrolysis. The formation of alcohols may be accomplished by absorption of olefins in cracked gases by sulfuric acid in the presence or absence of a catalyst followed by subsequent hydrolysis. Starting with the simple addition reactions, the whole field of aliphatic chemistry may be developed.

The following groups of compounds have been synthesized and produced commercially from cracked gases: alcohols, amines, chlorides, glycols, nitroglycols, chlorohydrins, ethers, ketones, acids, and esters.

Some of the outstanding uses for these products are as antifreeze agents (ethylene glycol), explosives (nitroglycols), agents to remove hydrogen sulfide or carbon dioxide from gases (triethanolamine), solvents for lubricating oil treatment (dichloroethyl ether), medicinals (acetoacetanilide), fumigants (ethylene oxide), solvents for plastics and lacquers (alcohols, esters, ketones), resins, synthetic rubber, and others. It is reported that two hundred thousand tires were produced in Russia during 1933 from the polymerization of butadiene from cracked gases.

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Rate of Heat Transfer from a Steam Coil to Water

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Despite the very common use of steam coils in heating liquids in tanks, there is but little information available as to the rate of transfer of heat from the surface of a steam coil to a surrounding liquid. In this article some data are given as to the rate of heat transfer from a steam-heated coil to water. In some of the experiments the water was stirred mechanically; in others the stirring was by natural convection only.

The apparatus used consisted of a cone-bottomed vertical cylindrical agitator of steel with a capacity of about 45 gallons, and was provided with a heating coil of standard 3/4-inch wrought iron pipe in the form of a vertical helix and with a single-bladed propeller agitator and a draft tube to prevent swirling (Figure 1). The heating coil had a total length of 17.3 feet, and was 1.05 inches in external diameter and 0.824 inch in internal diameter. The steam entering the coil was passed through a separator to remove entrained water. The pressure of the steam within the coil was controlled by an automatic pressure regulator and was registered on a calibrated gage. The condensate from the coil was discharged through a steam trap of the expansion type. The stirrer was driven at 250 r. p. m., the direction of rotation of the propeller blade being such that the water was lifted upward through the draft tube and discharged over its top into the space between the draft tube and the shell of the agitator. The temperature of the water was indicated by a thermometer, calibrated to 0.1° C. (0.18° F.) inserted through an opening in the side of the tank. The agitator was insulated with 1.5 inches of 85 per cent magnesia and was provided with a hinged steel cover.

The heat capacity of the agitator, as determined directly by experiment, was equivalent to that of 40 pounds of water. The heat generated by stirring was found experimentally to be 8.1 B. t. u. per minute. In a series of experiments made to determine the rate of loss of heat by radiation and convection from the outer surface of the agitator, the following results were obtained:

t_a = temp. of air, ° F.
t_w = temp. of water in agitator, ° F.
dQ_r/dT = rate of loss of heat by "radiation," B. t. u. per min.

$t_w - t_a$ ° F.	dQ_r/dT B. t. u. per min.
0	0
33.3	17.9
51.6	29.4
53.2	30.2
104	63.1

These results were plotted as a smooth curve from which it was possible to determine the rate of loss of heat by radiation at any known difference in temperature between the water and the air.

Heat Transfer with Liquid Stirred

In determining the rates of transfer of heat when the liquid was stirred continuously, a known quantity (approximately 40 gallons) of cold water was placed in the agitator and stirring was started. Then steam at the desired temperature was admitted to the coil. When the water was heating regularly and had attained a temperature of about 65° F., the collection of data was begun. Readings of the temperature of the water in the agitator were taken at 3-minute intervals until a final temperature of about 185° F. was attained.

From the experimental data were computed:

Q_c/hr./1° F. = amount of heat transferred through the coil in one hour under a temperature differential of 1° F. between the steam and the water.

$U_{ft.}$ = amount of heat, in B. t. u., transferred through one linear foot of $^3/_4$-inch pipe in one hour under a temperature gradient of 1° F. between the steam and the water.

C_1 = thermal conductance between the outer surface of the coil and the water, in B. t. u. per hour per square foot of outer surface of the coil per 1° F. difference between the temperature of the outer surface of the coil and the average temperature of the surrounding liquid. In computing C_1 the thermal conductance of the film between the condensing steam and the inner surface of the pipe was taken as 1800 B. t. u. per 1° F. per hour per square foot, and the thermal conductivity of the metal of the pipe was assumed to be 26 B. t. u. per hour per square foot per 1° F. per foot.

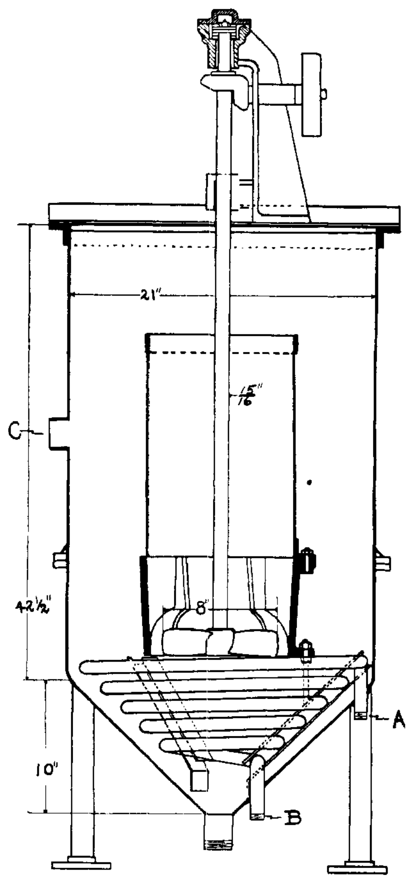

FIGURE 1. AGITATOR WITH HEATING COIL AND STIRRER

A. Steam inlet
B. Outlet for condensed steam
C. Opening for thermometer

The total amount of heat transferred through the coil in the entire period of heating was also determined, and from this value and the logarithmic average difference between the temperature of the steam and the temperature of the water an average value for Q_c/hour/1° F. was computed. From this, average values of $U_{ft.}$ and C_1 were calculated. The results are shown in Table I.

HEAT TRANSFER WITH LIQUID UNSTIRRED

In a second pair of experiments the water was not stirred while it was being heated. The agitator was charged with cold water, agitation was started, and steam at the desired pressure was admitted to the coil. When the water reached a temperature of about 75° F., the steam was shut off and the water was stirred for one minute. At the end of this time the temperature of the water was noted, the stirring was discontinued, and steam at the desired pressure was again admitted to the coil. The water was heated for 5 minutes without stirring, at the end of which time the steam was shut off and the water was stirred for one minute. After noting the temperature, the agitation was discontinued and the water was again heated for 5 minutes without stirring. This cycle of alternate heating and stirring was repeated until a final temperature of about 185° F. was attained. The results are shown in Table II.

TABLE I. RATES OF HEAT TRANSFER FROM STEAM COILS TO WATER WITH THE WATER STIRRED CONTINUOUSLY

RUN 1: HEATING STEAM AT 5 LB. GAGE PRESSURE = 226.1° F.; WEIGHT OF WATER IN AGITATOR = 330 LB.; TEMP. OF AIR = 73.6° F.

Time *Min.*	Temp. of water *° F.*	Q_c/hr./1° F.	$U_{ft.}$	C_1
0	70.5			
		1070	61.9	300
3	91.4			
		1175	68	343
6	111.2			
		1170	67.6	340
9	127.9			
		1005	58	278
12	140.2			
		1175	68	343
15	152.6			
		1000	57.8	274
18	161.6			
		870	50.3	230
21	168.4			
		945	54.6	255
24	174.9			
		890	51.4	236
27	180.3			
		920	53.1	246
30	185.2			
Average		1022	59.1	283

RUN 2: HEATING STEAM AT 12 LB. GAGE PRESSURE = 243° F.; WEIGHT OF WATER IN AGITATOR = 327 LB.; TEMP. OF AIR = 73.2° F.

Time *Min.*	Temp. of water *° F.*	Q_c/hr./1° F.	$U_{ft.}$	C_1
0	66.6			
		972	56.2	264
3	88.5			
		1125	65	320
6	110.5			
		1195	69.1	352
9	130.3			
		1220	70.5	359
12	147.4			
		1265	73.1	378
15	162.3			
		1000	57.8	274
18	172.2			
		810	46.9	210
21	179.2			
		846	48.9	222
24	185.7			
Average		1067	61.6	295

	RUN 1	RUN 2
Total heat lost by radiation, B. t. u.	1,241	932.1
Total heat utilized in heating water and agitator, B. t. u.	42,439	43,709.7
	43,680	44,641.8
Total heat supplied by stirring, B. t. u.	243	194.4
Total heat transferred through coil, B. t. u.	43,437	44,447.4
Log. av. difference in temp., ° F.	85.8	106
Q_c/hr./1° F. (av.), B. t. u./hr./1° F.	1,010	1,050
$U_{ft.}$ (av.), B. t. u./hr./ft./1° F.	58	60.7
C_1 (av.), B. t. u./hr./sq. ft./1° F.	278	292

TABLE II. RATES OF HEAT TRANSFER FROM STEAM COIL TO WATER WITH WATER NOT STIRRED

RUN 3: HEATING STEAM AT 5 LB. GAGE PRESSURE = 226.2° F.; WEIGHT OF WATER IN AGITATOR = 323 LB.; TEMP. OF AIR = 80.6° F.

Time *Min.*	Temp. of water *° F.*	Q_c/hr./1° F.	$U_{ft.}$	C_1
0	88.6			
		723	41.8	182.5
6	109.6			
		700	40.5	176.5
12	126.7			
		613	35.4	150
18	139.4			
		593	34.4	145
24	149.9			
		583	33.8	142.5
30	158.8			
		650	36.4	155.5
42	174.5			
		565	32.7	137
48	179.9			
		577	33.4	140
54	184.7			
Average		626	36.6	156

RUN 4: HEATING STEAM AT 12 LB. GAGE PRESSURE = 243.1° F.; WEIGHT OF WATER IN AGITATOR = 327 LB.; TEMP. OF AIR = 81.3° F.

Time *Min.*	Temp. of water *° F.*	Q_c/hr./1° F.	$U_{ft.}$	C_1
0	79.7			
		780	45	199.5
6	106.3			
		780	45	199.5
12	128.3			
		618	35.6	150.5
18	142.9			
		656	37.9	162.5
24	156.2			
		677	39.1	168.5
30	167.9			
		666	38.5	165.5
36	177.6			
		703	40.5	175.5
42	186.4			
Average		697	40.2	174.5

	RUN 3	RUN 4
Total heat lost by radiation, B. t. u.	2,154	1,521
Total heat utilized in heating water and agitator, B. t. u.	34,884	39,159
	37,038	40,680
Total heat supplied by stirring, B. t. u.	73	57
Total heat transferred through coil, B. t. u.	36,965	40,623
Log. av. temp. difference, ° F.	80	101
Q_c/hr./1° F. (av.), B. t. u./hr./1° F.	616.1	690
$U_{ft.}$ (av.), B. t. u./hr./ft./1° F.	35.7	39.8
C_1 (av.), B. t. u./hr./sq. ft./1° F.	152	172.3

RESULTS

The results for the individual sections of each of the experiments made with constant stirring vary considerably among themselves. The variation is due to the fact that complete mixing and equalization of the temperature throughout the mass of the water are not reached instantaneously, so that the temperatures as read are not the exact average temperatures of the charge. The error in any one reading is small, but, since the rise in temperature in each interval is also small, the relative error in determining the coefficient of heat transfer for a single interval is sometimes appreciable. The agreement between the average value for the coefficient of heat transfer, as calculated from the results for the individual intervals, and the average value as calculated from the total heat input and the logarithmic temperature difference is satisfactory.

These experiments show that the over-all rate of heat transfer between steam condensing in a coil of standard $^3/_4$-inch iron pipe and mechanically stirred water surrounding the coil is approximately 60 B. t. u. per hour per ° F. difference in temperature between the water and the steam per linear foot of pipe, and that the coefficient of heat transfer at the outer surface of the coil, under the conditions specified above, is approximately 285 B. t. u. per square foot per hour per ° F. difference in temperature. The rate of heat transfer increases slightly with increase in the temperature of the steam. When the water surrounding the coil is stirred by natural convection only, the over-all rate of heat transfer is from 36 to 40 B. t. u. per ° F. per hour per foot of coil, and the film conductance varies from 152 to 172 B. t. u. per square foot per hour per ° F. When the water is not stirred mechanically, the rate of heat transfer increases rather rapidly with an increase in the temperature of the steam. This is to be expected, since with higher steam temperatures there is more convection in the liquid.

RECEIVED June 7, 1934. The experimental results given in this article were obtained in an experiment performed as a part of the regular work in the course in chemical engineering laboratory at Cornell University.

Communication to the Editor on Orthophenylphenol as an Antiseptic

SIR: In the course of experiments conducted during the past year or more with diphenyl compounds which have recently come into the market in commercial quantities, it was noted that the orthohydroxy compound, and certain derivatives thereof, have possessed interesting possibilities as antiseptic and disinfectant agents for therapeutic employment.

A series of tests has been performed on orthophenylphenol and its derivatives in which it appears that these products have a high antiseptic value and are relatively nontoxic to the animal economy. It also appears that the phenol possesses definite penetrating properties and can be used not only for its own effect, but to bring about penetration of other chemicals that ordinarily do not exert their effects beyond the surface of the skin.

The ability of orthophenylphenol to penetrate the intact skin and become effective beyond the site of administration was first tested in agar plate media, and the killing effect on bacteria was noted. Then well-known substances such as menthol, camphor, thymol, and methyl salicylate were mixed therewith, and it was found that they, too, had gone into the medium beyond the point of contact. This led to the belief that beneficial effects in local congestion might be enhanced by combining the remedial agents with orthophenylphenol in salves, ointments, sprays, and the like, commonly used for treating colds and so-called rheumatic conditions and muscular aches and pains. In an extended series of tests whereby the combination in the form of an ointment was applied to the surface of the skin and allowed to remain in contact therewith, it was definitely proved that the substances were absorbed, and sufficient material reached the blood stream to give evidence in the eliminations—that is, the urine. These tests were checked by running another series in which menthol, camphor, methyl salicylate, and the like were used alone in the salve, and no evidence of their presence was found in the urine; when orthophenylphenol occurred in the mixture, it was immediately demonstrated that absorption on penetration had occurred. Inasmuch as the organic compounds above mentioned have a wide use in the treatment of local congestion, it would appear that their effects can be materially enhanced by combining them with certain of the diphenyl compounds.

The nontoxic feature of the orthophenylphenol suggested that it might be useful in combination with other remedies used for combating conditions of the throat accompanied by cough and irritation, which might be accelerated by the presence of bacteria. It was found that the product was well tolerated in tablets and gargling mixtures designed for application to the respiratory passages, and that there was a soothing effect noted at once in relieving the coughing spasms and shortening the course of the attack. It might be hoped that some remedial effect might be expected in whooping cough, especially in shortening the course of the difficulty and giving the sufferer relief from spasms. Orthophenylphenol is well tolerated by children.

Since the orthophenylphenol was found to be destructive to the pathogenic organisms of the *Streptococcus* and *Staphylococcus* groups, it was thought well to determine whether or not combinations of the soluble sodium compound in physiological salt solution could be introduced into the blood stream without injury, and if so, whether or not the effect of the antiseptic on living organisms present therein would be noticeable.

A series of tests performed on rabbits showed that the blood supply suffered no adverse action when the solution above mentioned was injected therein, even large quantities being tolerated with no aftereffects.

Following these tests which showed that the blood suffered no ill effects from the administration, a series of tests was performed on some rabbits in whose blood living cultures of *Staphylococcus aureus* had been demonstrated. After considerable experimentation in order to control the dosage, the organisms were killed, and the animals survived; in those instances where no injections were made, the creatures succumbed.

Two interesting cases of *Streptococcus* and *Staphylococcus* infections of the blood stream in human individuals were successfully treated with injections of sodium orthophenylphenol in physiological salt solution accompanied by transfusion. Definite improvement followed the early administrations, the subjects experiencing a reduction in temperature and a general improvement in condition. On recovery, the blood gave negative evidence of infection.

These tests lead to the hope that there is a possibility of working out a satisfactory remedy for treating septicemia by the use of an antiseptic which is not harmful to the blood supply.

The research is being continued and the results will be published in detail.

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WASHINGTON, D. C.
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