CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS, OTTAWA

MINES BRANCH

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TB 4

PRICE 25 CENTS

A LABORATORY STUDY ON THE AGGLOMERATION OF COAL IN THE PRESENCE OF PLASTICIZING AGENTS AT MODERATE TEMPERATURES AND HIGH PRESSURES

by

LEWIS H. KING

FUELS DIVISION

AUGUST 26, 1959

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*An extended summary was presented at the Sixth Biennial Briquetting Conference of the International Briquetting Association, East Glacier Park, Montana, August 24-26, 1959, by E. Swartzman of the Fuels Division.
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SYNOPSIS

Briquets of 20 gm of crushed coal were prepared in a cylindrical steel die with a hand-operated hydraulic press. Using a high volatile A bituminous coal, the briquetting temperature and pressure, particle size, and type and amount of plasticizing agent (usually creosote oil) were varied for a large number of runs to determine the influence of these factors on the compressive strength of the briquets. At a temperature of 250°C and a pressure of 6 tons per square inch, briquets were prepared that were hard, compact, dustless, and had a compressive strength of 7,000 to 9,000 psi. These briquets were much stronger than those prepared with asphalt binder.

Microscopic examinations were conducted on polished surfaces of the briquets and were found useful in following and interpreting the effects of different briquetting conditions. Maceral analyses were also made, to determine the influence of petrographic composition on briquet quality.

Subbituminous to low volatile bituminous coals were studied in a cursory manner, and it was shown that coals between high volatile B and low volatile bituminous rank produced the best briquets.

Reference is made to an earlier investigation in which this technique was developed to fabricate briquets of crushed coal which were of sufficient strength to permit the preparation of thin sections for microscopic examination.

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* Senior Scientific Officer, Fuels Division, Mines Branch, Department of Mines and Technical Surveys, Ottawa, Canada.

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ÉTUDE AU LABORATOIRE SUR L'AGLOMÉRATION DE LA HOUILLE EN PRÉSENCE D'AGENTS PLASTIFIANTS, À DES TEMPÉRATURES MODÉRÉES, SOUS DES PRESSIONS ÉLEVÉES

par

Lewis H. King*

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RÉSUMÉ

On a préparé des briquettes de 20 g. de houille broyée dans une matrice cylindrique d'acier, à l'aide d'une presse hydraulique à main. A partir d'une houille grasse A, à forte teneur en matières volatiles, on a fait varier la température et la pression de briquetage, la dimension des particules, ainsi que le type et le volume d'agent plastifiant (ordinairement de l'huile de créosote) au cours d'un grand nombre d'essais, pour déterminer l'influence de ces facteurs sur la résistance à la compression des briquettes. A la température de 250°C. et sous une pression de 6 tonnes au pouce carré, on a obtenu des briquettes dures, compactes, sans poussière, et d'une résistance à la compression de 7,000 à 9,000 livres au pouce carré. Ces briquettes étaient beaucoup plus résistantes que celles qu'on prépare à l'aide d'un liant bitumineux.

L'examen au microscope des surfaces polies de ces briquettes s'est avéré utile, car il permet de suivre et d'interpréter les effets des différentes conditions de fabrication des briquettes. On a aussi fait des analyses de briquettes macérées, afin de déterminer l'influence de la composition pétrographique sur la qualité des briquettes.

On a fait une étude rapide des types de houilles sub-bitumineuse à grasse pauvre en matières volatiles, et il a été établi que les meilleures briquettes étaient celles qu'on obtenait des houilles grasses comprises entre la catégorie B à forte teneur en matières volatiles et la catégorie à faible teneur en matières volatiles.

L'auteur mentionne une investigation antérieure au cours de laquelle cette technique a été mise au point en vue de fabriquer, à partir de houille broyée, des briquettes assez résistantes pour en prélever des sections minces propres à l'examen au microscope.

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CONTENTS

(31 pages, 4 tables, 12 figures)

INTRODUCTION

In the light of the current interest in the field of hot briquetting of coals, it has been decided to report on some aspects of a laboratory investigation into the agglomeration of coal which was carried out at the Coal Research Division of the Geological Survey of Canada in Sydney, Nova Scotia, during the period 1954-56. The initial purpose of the investigation was to develop a method whereby crushed coal could be fabricated into pellets of sufficient strength to permit the preparation of thin sections for microscopic examination. This was accomplished by heating and pressing the crushed coal in the presence of a plasticizing agent, to form a " self-bonded" briquet. This method, and its application to the field of coal petrography, were presented in 1957 before the Coal Group of the Geological Society of America.(1)

In the course of delineating the range of the method, the influence of such factors as rank, petrographic composition, particle size, temperature, pressure, and type and amount of plasticizing agent was investigated. The resultant pellets were evaluated by measuring the compressive strength, as well as by megascopic and microscopic examination. In the initial paper, only those data were presented that indicated optimum conditions for the preparation of laboratory specimens. It is the purpose of the present paper to present a more comprehensive account of the laboratory results, and to discuss some aspects of the self-binding characteristics of crushed coal. The idea of plasticizing the coal before briquetting is essentially in conformity with work by Berkowitz (2) (3) and Gregory (4).

It is appreciated that the practical significance of the laboratory results is limited; nevertheless, the results should indicate, in relative terms, the influence of some of the factors peculiar to hot briquetting of crushed coal.

EXPERIMENTAL

Apparatus

The apparatus used for agglomerating the crushed coal consisted of a 50-ton, hand-operated hydraulic press designed to allow for easy removal of either hot or cold briquets from the moulds; a case-hardened, 1-1/8 in. diameter, cylindrical steel mould with removal top and bottom plungers; a hinged, split heating jacket; a removable water jacket for rapid cooling; and a thermocouple pyrometer to measure the temperature at the base of a well in the top plunger of the die.

A Riehle Brothers, motor-driven, hydraulic testing machine of 30,000 lb capacity was used for measuring the compressive strength of the briquets.

Technique and Procedure

Samples of 20 gm of crushed coal were placed in the mould and heated to a specified temperature, after which a specified pressure was applied. Immediately after the application of pressure, the mould was cooled to about 80°C and the briquet was removed. Approximately 20 minutes was required for the preparation of each briquet, the pressure being applied for about 5 minutes.

The coals investigated range in rank from low volatile bituminous to subbituminous, but the majority of tests were conducted on high volatile A bituminous coal. In the latter tests, the particle size, briquetting temperature and pressure, and the amount and type of plasticizing agent* were varied for a large number of runs, on a given coal, in order to determine the influence of these factors on the compressive strength of the briquets. The most extensive work was done with creosote oil (250-350°C fraction) as a plasticizing agent, but some work was also carried out with phenanthrene because of its high solvent action on coal. Anthracene

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* A plasticizing agent is a substance which when mixed with a high polymer (in this case coal) modifies many of its properties. Plasticizing agents aid the briquetting process by lowering the softening temperature and modifying the mechanical properties of the coal particles.

oil and coal tar were also tested in a qualitative manner. In each case the plasticizing agent was blended with the crushed coal before the mixture was placed in the mould. Prior to the compression test, many of the samples were polished and examined microscopically, under reflected light, for degree of packing, extent of microscopic fracturing, and nature of deformation in the grains.

To determine the role of petrographic composition, the briquetting conditions were held constant and briquets of high volatile A bituminous coal of varying petrographic composition were prepared and tested for compressive strength.

In order to compare the self-bonded briquets with a more familiar product, both asphalt-bonded and self-bonded briquets were prepared from -1/8 in. slack coal and their compressive strengths were determined.

The compression tests were conducted by placing the flat ends of the cylindrical pellets against the platens of the testing machine, and the ram was advanced at a rate of 0.02 in. per minute. For the hard briquets, the rate of pressure increase was slow up to approximately 3,000 psi, and then increased rapidly to 7,000-9,000 psi where the briquets failed explosively. The rate of pressure increase for the weaker briquets was slow from beginning to end, and the failure was of a gradual crushing nature. All specimens broke within a period of 1.5 to 2 minutes from the beginning of the test.

Preparation of Samples

Column samples were collected from the Harbour seam (high volatile A bituminous) in the Princess, No. 26 and Florence collieries of the Sydney coalfield, and were designated respectively as IV 27, IV 28 and IV 29. These samples were split at 2-in. intervals and air-dried, after which a portion of each increment was stage-crushed to -20 mesh (Tyler), blended with a 5% addition of creosote oil, and briquetted at 250°C under 6 tons per sq in. pressure. The briquets were polished, and petrographic maceral analyses were made using the point-count method. These briquets were then used for the study relating petrographic composition and compressive strength. Hand-picked samples of dull coal were also collected in the Florence colliery for this study.

A composite sample was prepared from the remaining portions of the three column samples, and was stage-crushed to -3.5, -20, -35 and -150 mesh. These size fractions were used for the study relating compressive strength to various briquetting conditions,

Briquets made from coals of various rank, blends of different ranks, and blends of coke breeze with high volatile A bituminous coal, were also prepared and examined qualitatively. The location and rank of these samples are shown later in Table

5. Stage-crushed samples of -65 mesh were prepared for these runs; otherwise, the briquetting conditions were identical to those for the petrographic work.

Chemical Analysis

Chemical analyses were obtained for two briquets and their respective raw coals. The briquets were prepared at 250°C with a briquetting pressure of 6 tons per sq in. and plasticized with a 5% addition of creosote oil. The results are tabulated in Table 1.

TABLE 1

Chemical Analyses of the Briquets and Their Respective Raw Coals

Sample	Moisture (as received)	Dry Basis				
		Volatile Matter %	Fixed Carbon %	Ash %	Sulphur %	BTU
Harbour composite; raw coal	1.56	37.32	59.66	3.02	1.19	14,775
Briquet of composite sample with 5% creosote oil	1.05*	38.00	58.68	3.32	1.31	14,680
IV 29 (high sulphur zone); raw coal	2.00	37.52	55.14	7.34	3.77	-
Briquet of IV 29 with 5% creosote oil	1.10*	38.20	53.84	7.96	3.52	-

* This may not be entirely moisture; it may include light fractions from the creosote oil.

RESULTS

Influence of Briquetting Conditions on Compressive Strength

Figures 1-7 represent isothermal plots of briquetting pressures against compressive strength for briquets prepared from different particle sizes of high volatile A bituminous coal, and with variable amounts of plasticizing agent. The discontinuous nature of these curves may be due to the fact that each point represents a single determination. The wide fluctuations are probably the result of heterogeneity with respect to micro and macro fracturing, and discontinuities at grain boundaries where high stress concentrations can accumulate.

On the other hand, a closer inspection of the curves shows that certain general trends are depicted. For the majority of the curves, as the briquetting pressure increases the compressive strength increases and then passes through a maximum. The maximum usually occurs between 4 and 10 tons per sq in. briquetting pressure, but for individual cases the range is much narrower. The occurrence of this optimum briquetting pressure

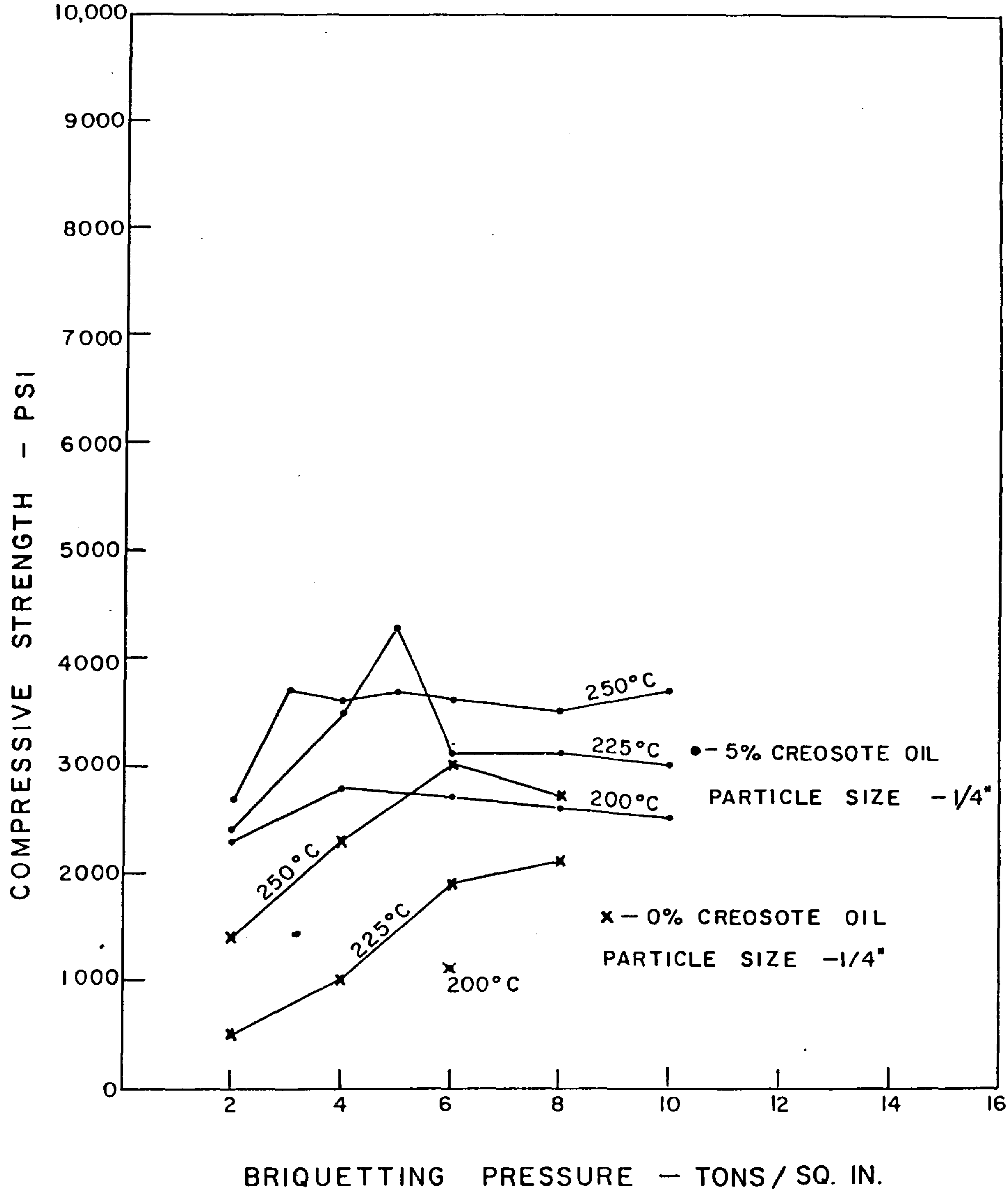

Figure 1. - Variation of compressive strength with briquetting pressure, at constant temperature, for briquets prepared from -3.5 mesh, high volatile A bituminous coal, with and without a plasticizing agent.

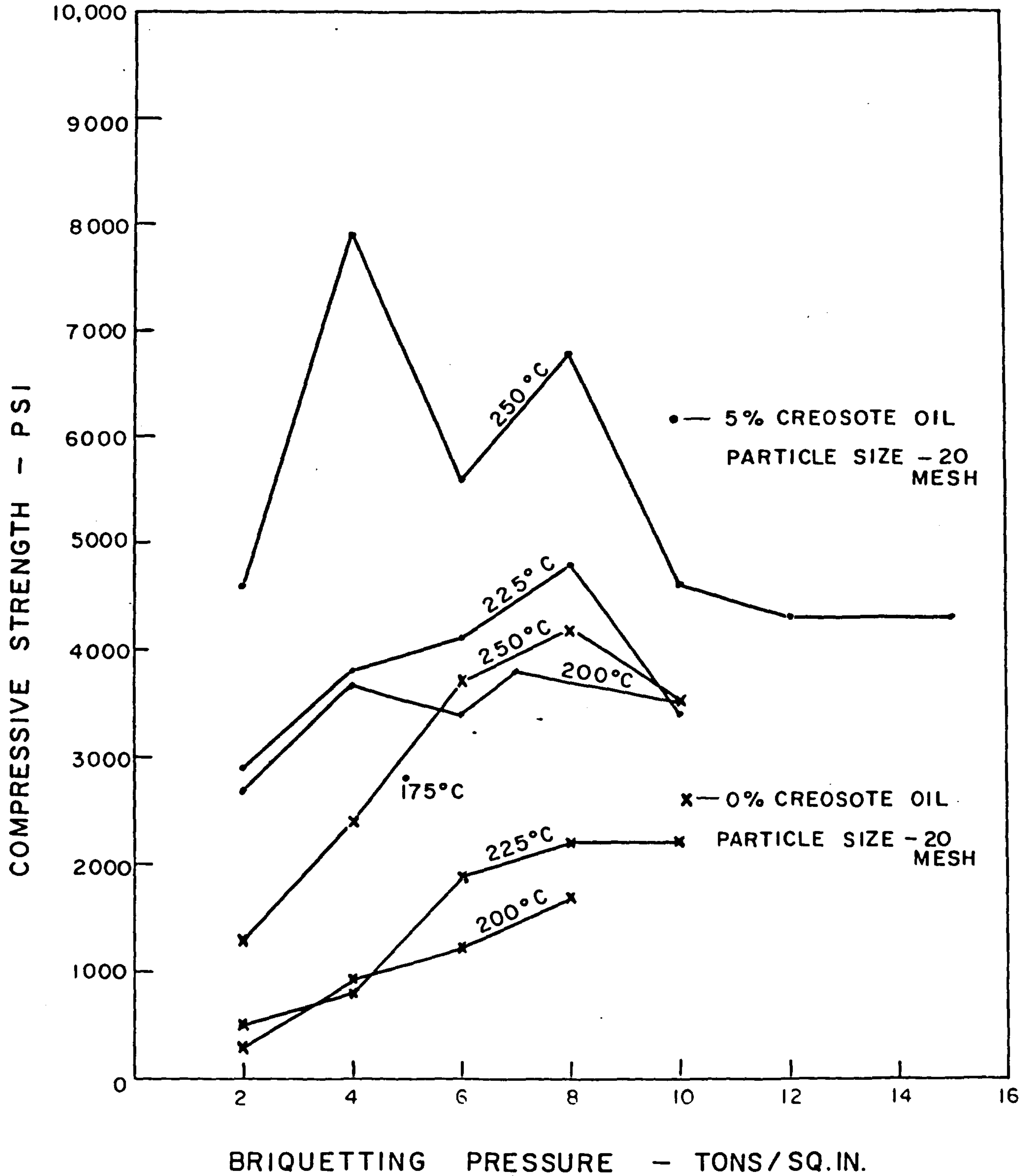

Figure 2. - Variation of compressive strength with briquetting pressure, at constant temperature, for briquets prepared from -20 mesh, high volatile A bituminous coal, with and without a plasticizing agent.

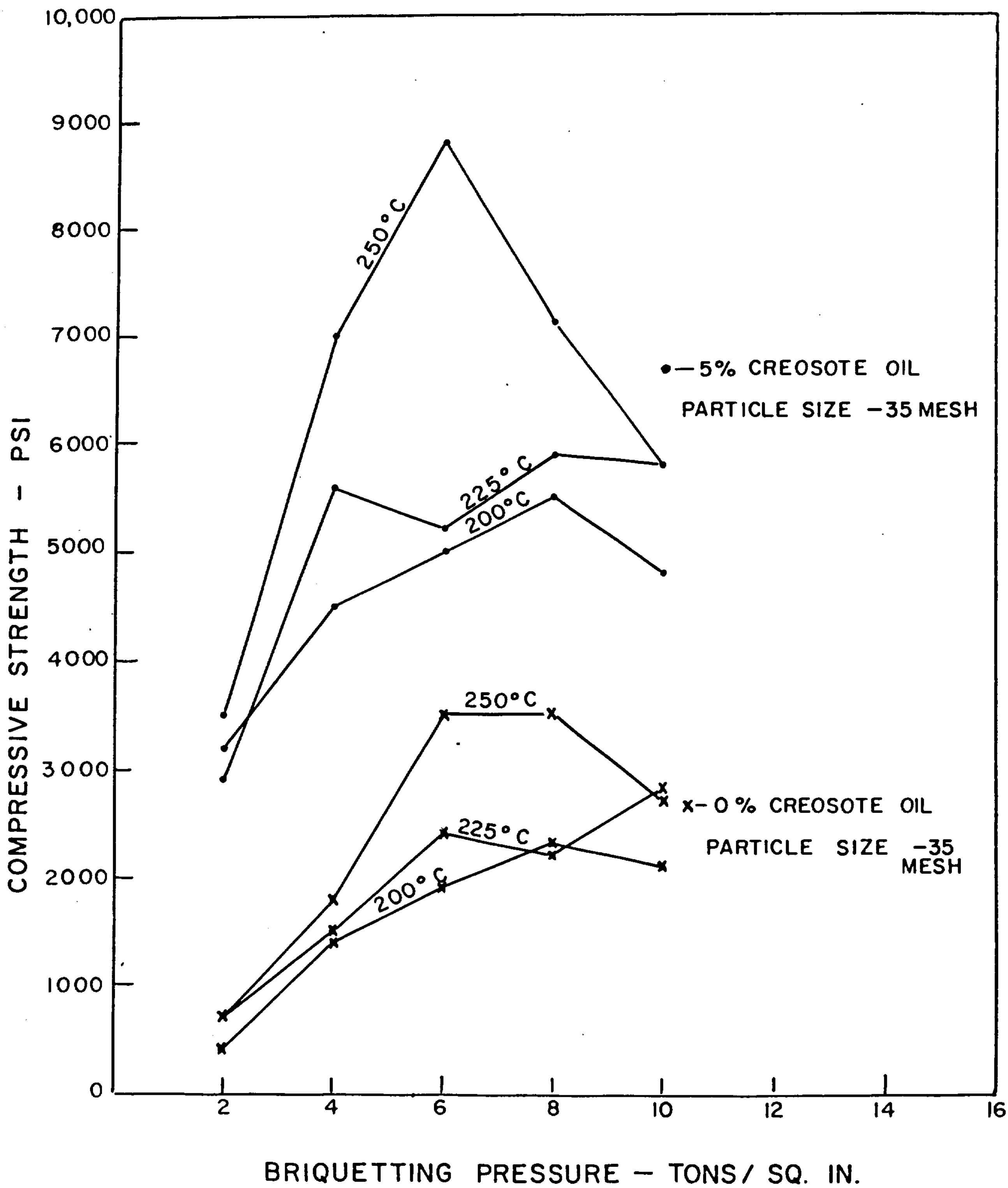

Figure 3. - Variation of compressive strength with briquetting pressure, at constant temperature, for briquets prepared from -35 mesh, high volatile A bituminous coal, with and without a plasticizing agent.

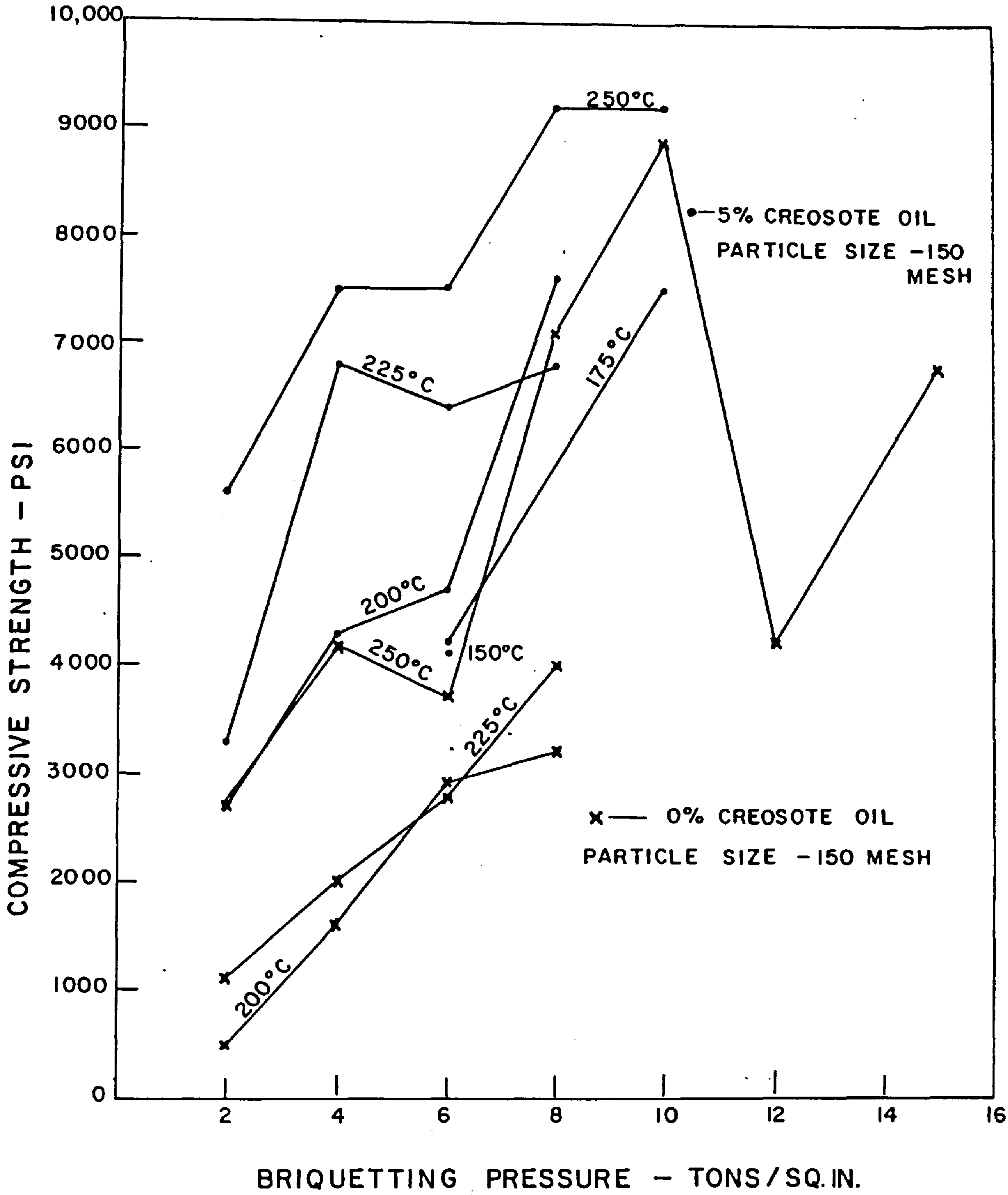

Figure 4. - Variation of compressive strength with briquetting pressure, at constant temperature, for briquets prepared from -150 mesh, high volatile A bituminous coal, with and without a plasticizing agent.

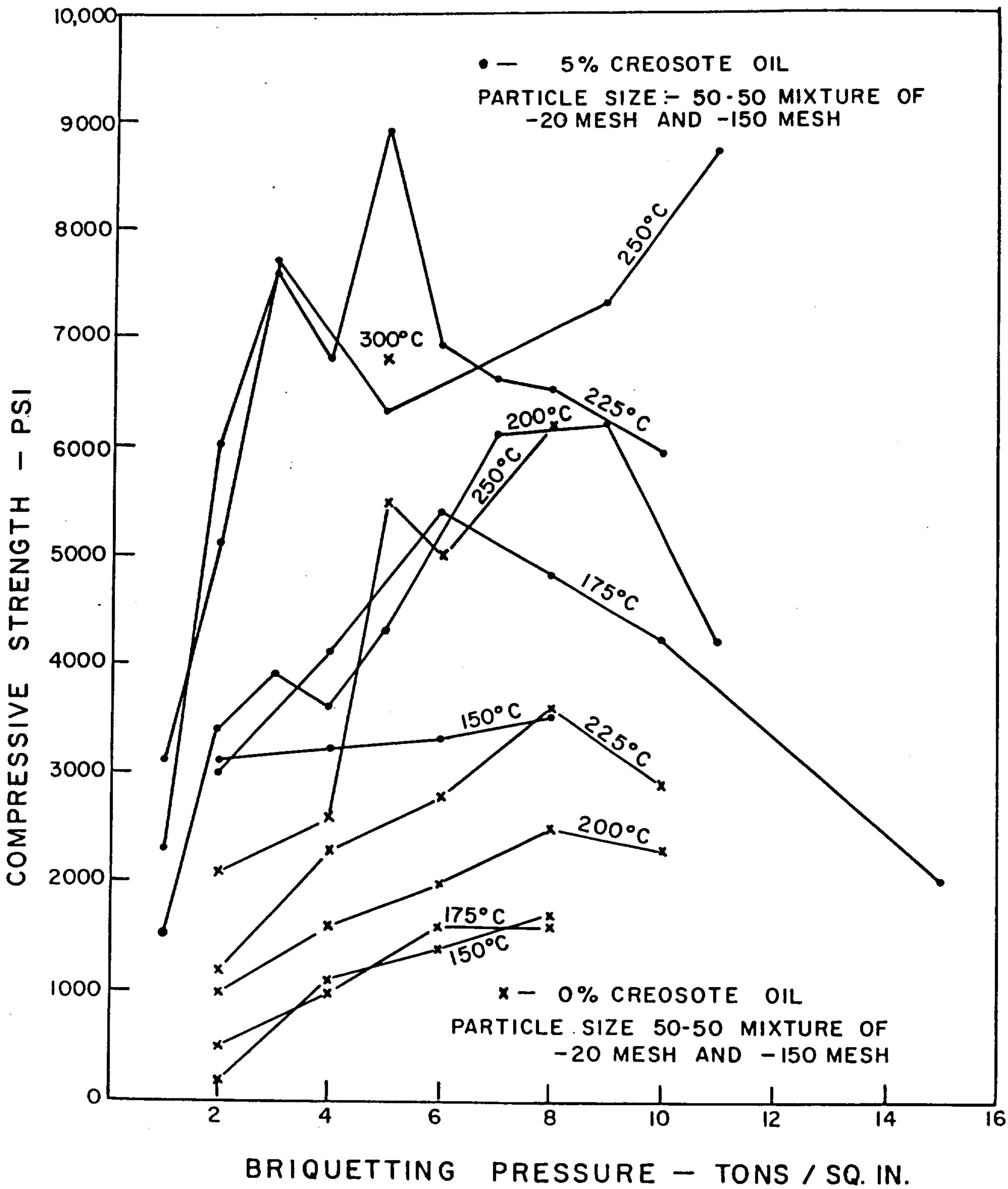

Figure 5. - Variation of compressive strength with briquetting pressure, at constant temperature, for briquets prepared from a 50-50 mixture of -20 and -150 mesh, high volatile A bituminous coal, with and without plasticizing agent.

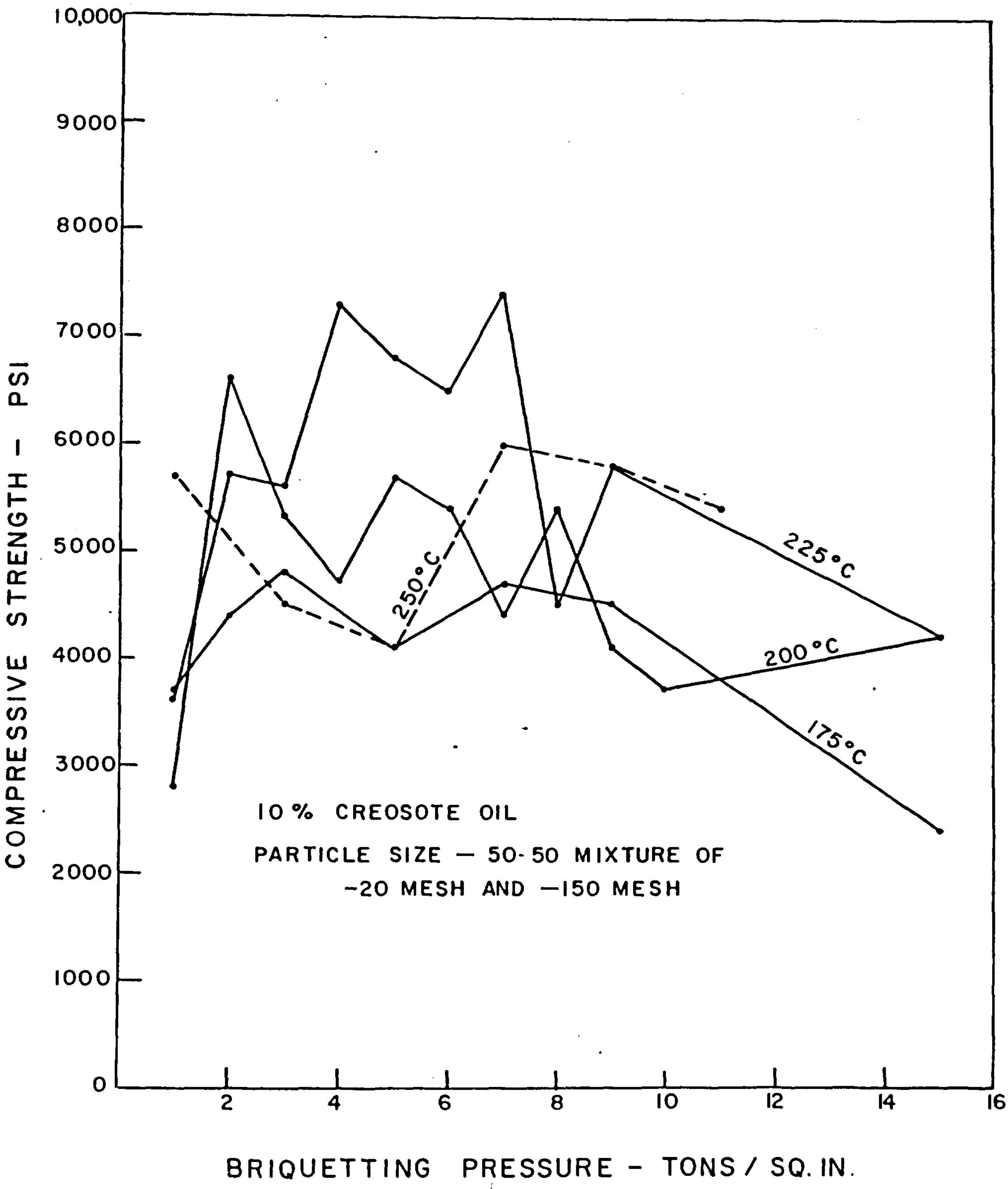

Figure 6. - Variation of compressive strength with briquetting pressure, at constant temperature, for briquets prepared from a 50-50 mixture of -20 and -150 mesh, high volatile A bituminous coal with a 10% addition of creosote oil.

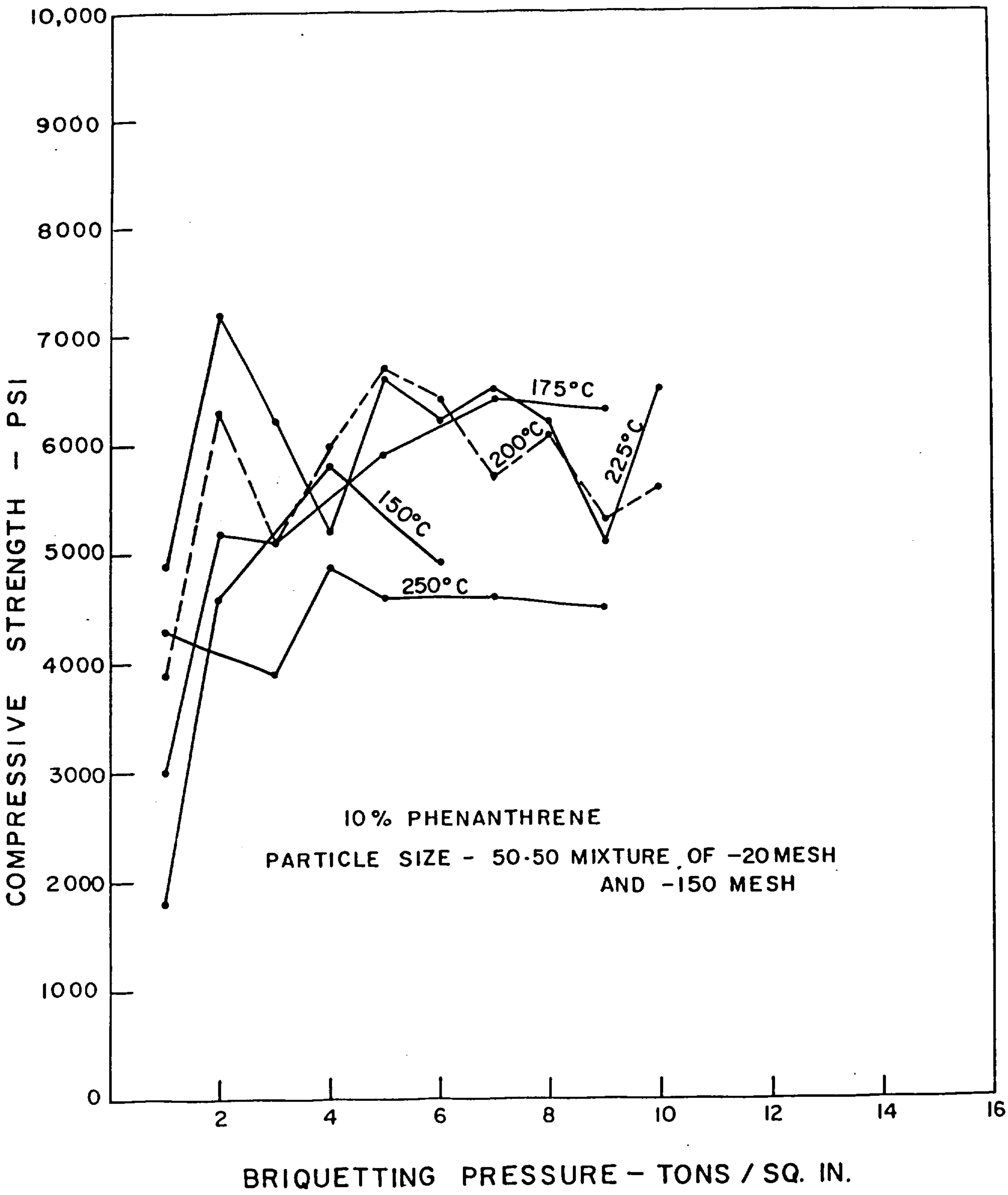

Figure 7. - Variation of compressive strength with briquetting pressure, at constant temperature, for briquets prepared from a 50-50 mixture of -20 and -150 mesh, high volatile A bituminous coal with a 10% addition of phenanthrene.

is due to the nature of the die and to the ease with which briquets can be removed from it. With briquetting pressures above approximately 10 tons per sq in. the briquets jam, and the high pressures required for their subsequent removal fracture and weaken them.

Figures 1-5, as well as Table 2, show that the compressive strength increases with an increase in briquetting temperature for both the 5% and the 0% creosote plots. This increase in strength results from an increase in the plastic properties of the coal, and the consequent tight packing of the particles.

For higher concentrations of plasticizing agent (Figure 6), the compressive strength reaches a maximum at the 225°C isotherm and then declines at higher temperatures. The creosote is quite volatile at these temperatures; hence at higher concentrations the escaping gases might cause fracturing. A similar result was obtained by adding 10% of phenanthrene (Figure 7), but the maximum was attained at a lower temperature. The decline in briquet quality with the higher concentrations of creosote and phenanthrene might also be the result of unreacted solvent remaining at the grain boundaries. This residue of solvent was quite apparent in thin sections prepared from the phenanthrene pellets.

The graphical results on particle size, shown in Figures 1-5, are epitomized in Table 2. The compressive strength data

TABLE 2

Summary of Figures 1-5, Showing the Influence of Particle Size, Temperature, and Plasticizing Agent on the Compressive Strength of the Briquets

Particle Size	Average compressive strength, in psi, for briquets prepared between 4 and 8 tons per sq in. pressure			Plasticizing Agent
	200°C Isothern	225°C Isotherm	250°C Isotherm	
- 3.5 mesh	2,700	3,500	3,620	5% creosote oil
- 20 "	3,630	4,230	6,770	" " "
- 35 "	5,000	5,570	7,630	" " "
- 150 "	5,530	6,670	8,070	" " "
50-50 mixture -20 and -150 mesh	4,670	7,120	7,100	" " "
- 3.5 mesh	1,100	1,670	2,670	0% creosote oil
- 20 "	1,270	1,630	3,430	" " "
- 35 "	1,870	2,030	2,933	" " "
-150 "	2,570	2,930	5,000	" " "
50-50 mixture -20 and -150 mesh	2,030	2,900	4,600	" " "

were condensed by obtaining the average compressive strength of the briquets prepared between 4 and 8 tons per sq in. pressure. These data show that the strength of the briquets is substantially increased by a decrease in particle size. For example, the compressive strength is approximately doubled for a decrease in particle size from -3.5 mesh to -150 mesh, and this applies to both the plasticized and unplasticized briquets.

Table 2 also shows the extent to which the strength of the briquets is increased by the addition of the plasticizing agent. In many cases the strength is doubled. Actually, it is thought that these increases in the compressive strength are quite modest figures and that if a more critical test were to be applied (possibly a tumbler test) the differences would be even greater. This inference is based on the megascopic and microscopic appearance of the briquets, the plasticized briquets being far superior because they exhibit fewer fractures and are more uniformly packed. Figure 8 shows a briquet of -35 mesh coal prepared at 250°C under a pressure of 6 tons per sq in. The briquet is free from fractures, is completely dustless, and has a hard lustrous surface.

Anthracene oil and coal tar were only investigated in a cursory manner. The results with anthracene oil seem to be comparable to those for creosote oil, but when coal tar is used the briquets are only of fair quality. There are, undoubtedly, many other coal solvents which would perform equally as well as creosote, but in making a choice one should consider the specificity of the solvent with respect to coal rank.

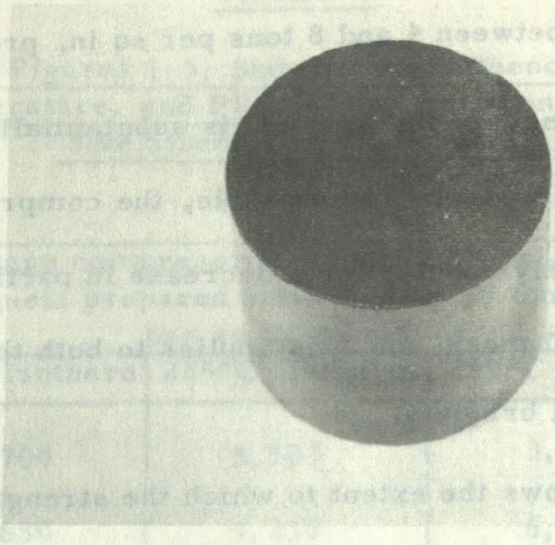

Figure 8. - Typical briquet of -35 mesh, high volatile A bituminous coal, prepared at 250°C under a pressure of 6 tons per sq in. with a 5% addition of creosote oil.

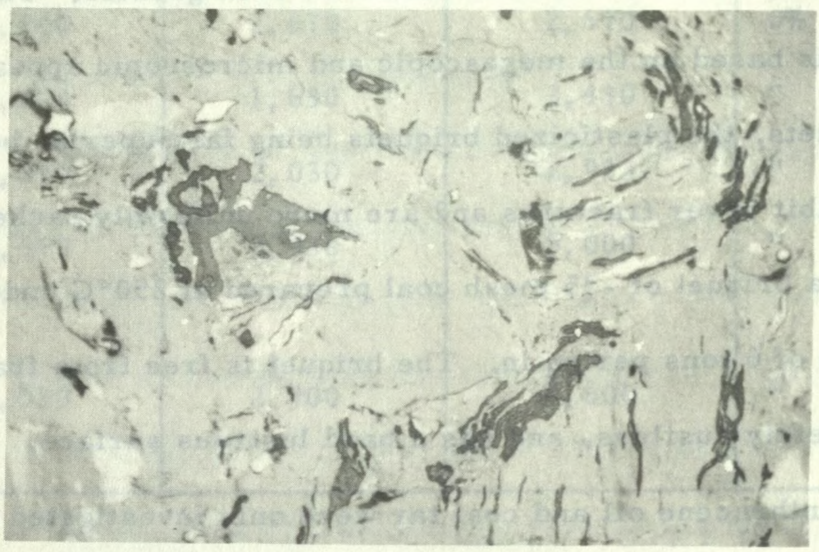

Figure 9. - Photomicrograph of a polished surface of a briquet of -65 mesh, high volatile A bituminous coal, prepared at 250°C under a pressure of 6 tons per sq in. and with a 5% addition of creosote oil. Magnification: X150, under oil immersion. The light grey groundmass is vitrinite, the white fragments are inertinite, and the dark grey bodies are exinite.

Comparison of the Compressive Strength of Asphalt-Bonded and Self-Bonded Briquets

Table 3, a comparison between the self-bonded and asphalt-bonded briquets, effectively illustrates the exceptional strength of the former product. Both types were prepared using the same mould, but the briquetting temperature and pressure for the asphalt type were chosen to conform with standard briquetting practice for a constant volume press. The conditions for the self-bonded briquets were similar except for the addition of a plasticizing agent, and a higher briquetting temperature. The data of Table 3 show that at comparable pressures the self-bonded briquets are approximately six times stronger.

TABLE 3

Comparison of the Compressive Strengths of Asphalt-bonded and Self-bonded Briquets

Sample	Briquetting Temp. °C	Briquetting Pressure, tons/ sq in.	No. of Samples	Mean Compressive Strength, psi	Standard Deviation of Compressive Strength, psi
-1/8" slack coal plasticized with 5% creosote oil	250	1	10	1868	± 303
	250	2	10	2085	± 308
-1/8" slack coal prepared with 6.5% asphalt	65	1	10	301	± 21
	65	2	10	377	± 15

Megascopic and Microscopic Observations

The degree of packing and the nature of the bond between particles are the most important factors contributing to the unusual strength of the self-bonded briquets, and these factors can be readily studied and qualitatively evaluated with the microscope. Figure 9 is a photomicrograph of a polished surface of a briquet of high volatile A bituminous coal prepared at 250°C under a pressure of 6 tons per sq in. with a 5% addition of creosote oil. The illustration shows that the coal particles are packed so intimately that only the petrographic texture of the particles makes it possible to ascertain where actual contact takes place. Close packing of this nature, where there is complete contact between the original grain surfaces, indicates that the grains must have been rendered plastic throughout and not just near their surface. Briquets prepared under the same conditions, but without the addition of a plasticizer, also show a close degree of packing when examined microscopically; however, they differ in that fracturing at grain boundaries, as well as secondary fracturing across grains, is quite prevalent. Microscopic examinations of briquets that were prepared at a pressure of 6 tons per sq in. without a plasticizing agent showed that with a decrease in temperature below 225-250°C., the amount of void increased sharply. Therefore, the plasticity of the particles as a whole is to a large extent a function of temperature. The plasticizing agent apparently exerts its greatest influence at the outer fringe of the particles, where it increases the degree of plasticity caused by thermal agitation alone and augments strong bonding between particles. The action of the plasticizing agent is largely dependent on the length of time during which it is in contact with the coal at the higher temperatures. The chemical analyses of Table 1 show that much of the creosote is volatilized when the briquets are prepared at 250°C; this reduction in concentration of creosote would also reduce the degree of plasticity.

Both the megascopic and the microscopic examinations reveal that the grains are not uniformly packed throughout the briquets, even when a plasticizer is added. This is due to the fact that the pressure is not equal in all directions in a granular mass. The pressure is greater near the walls of the container and produces the well known " skin effect", so that the most highly compacted areas are along the sides and especially at the corners. The particles in these areas are also the most highly deformed, and they exhibit both folding and shearing when sections prepared parallel to the pressure axis are examined. When the polished sections are prepared on the flat ends of the cylinder, normal to the direction of pressure, the most apparent evidence for deformation is the lack of voids between particles (see Figure 9).

Fractures, if present, are also quite systematic and symmetrical, and are usually manifest either as radiating tension fractures which intersect at the axis of the cylinder, or as fracture planes developed normal to the cylinder or pressure axis. The tension fractures are more prevalent in briquets prepared from -150 mesh particles, at a pressure below the optimum. The fractures developed normal to the axis of the cylinder appear to be an unloading phenomenon. In briquets prepared from -3.5 mesh material, the fractures are more irregular and show a greater tendency to follow grain boundaries.

Relation of Petrographic Composition to Compressive Strength

The relation of petrographic composition to the compressive strength of the briquets is shown in Figures 10-12. As mentioned earlier, the variation in petrography was attained by splitting each column sample into subsamples representing 2-in. intervals. In Figures 10-12, the maceral composition of each briquet, prepared from a subsample, is plotted on a ternary diagram, and its com-

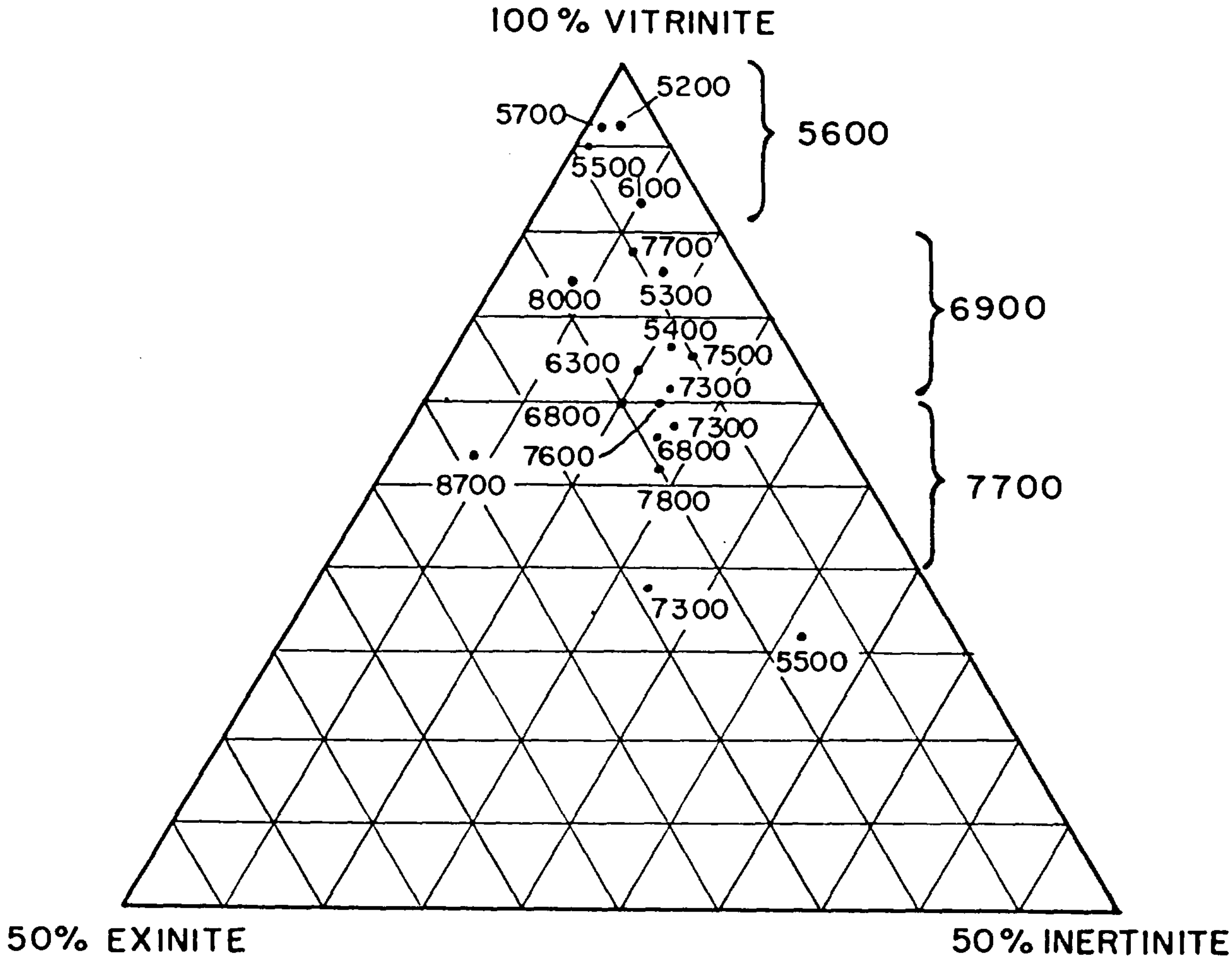

Figure 10. - Ternary diagram showing the relation between the petrographic maceral composition of subsamples from column sample IV 27, and their compressive strengths. The briquets were prepared from -20 mesh particles at 250°C, under a pressure of 6 tons per sq in., and with a 5% addition of creosote oil.

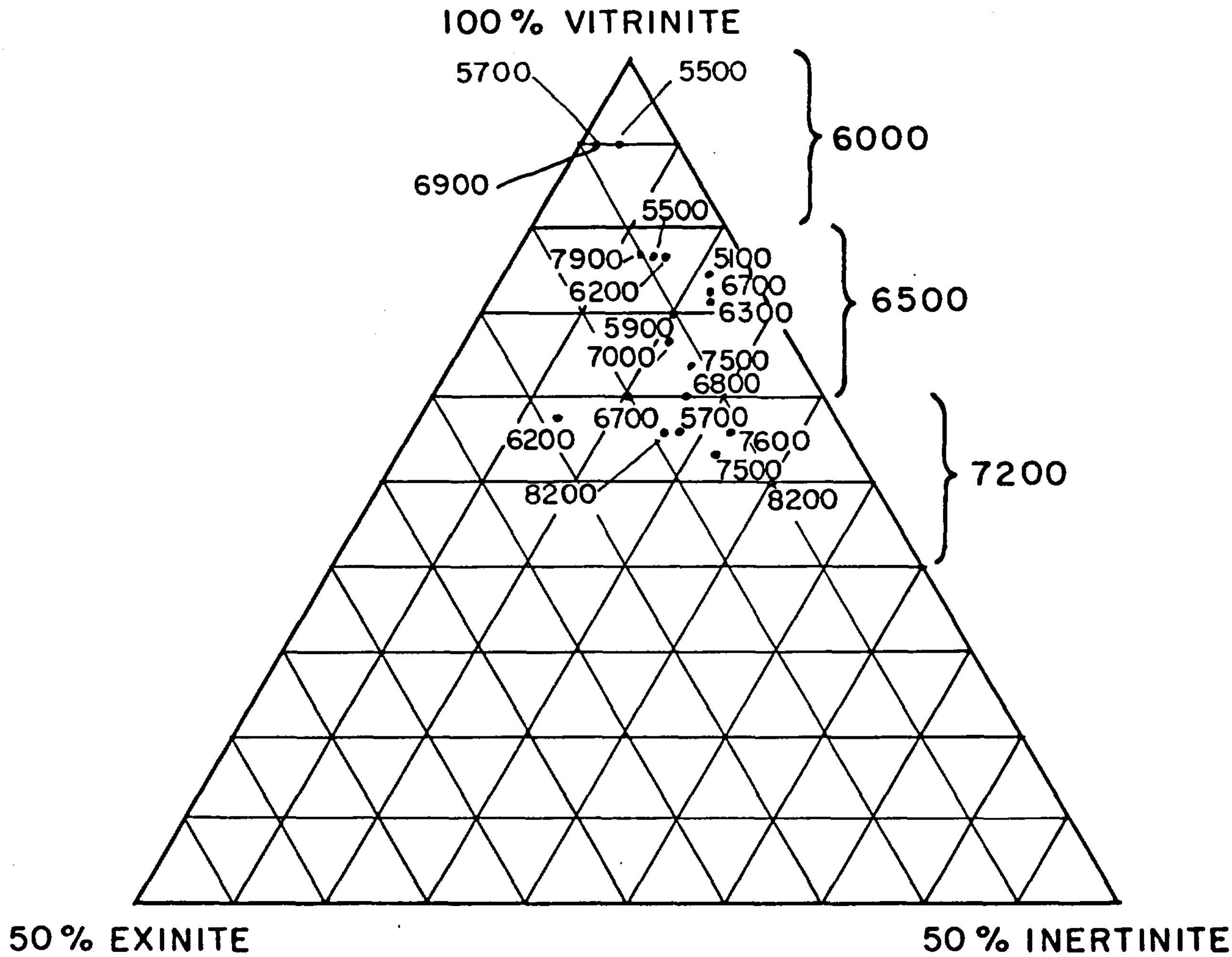

Figure 11. - Ternary diagram showing the relation between the petrographic maceral composition of subsamples from column sample IV 28, and their compressive strengths. The briquets were prepared from -20 mesh particles, at 250°C, under a pressure of 6 tons per sq in., and with a 5% addition of creosote oil.

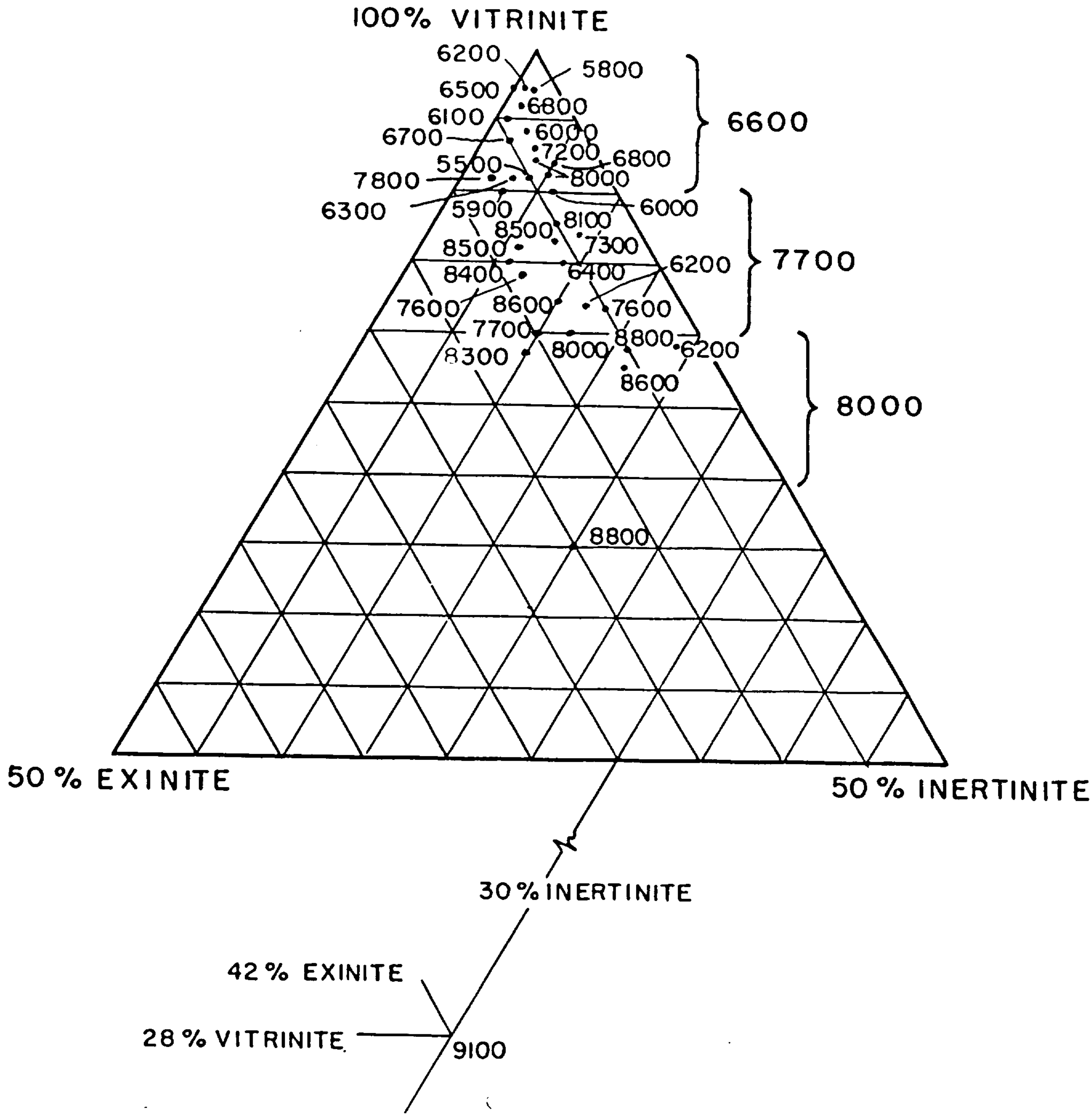

Figure 12. - Ternary diagram showing the relation between the petrographic maceral composition of subsamples from column sample IV 29, and their compressive strengths. The briquets were prepared from -20 mesh particles, at 250° C, under a pressure of 6 tons per sq in., and with a 5% addition of creosote oil.

pressive strength is indicated adjacent to the point. The data show a trend to stronger briquets with decrease in vitrinite, but the correlation is not well defined on the diagrams. The scatter is probably caused by circumstances similar to those encountered in Figures 1-7, so a briquet which should be strong by virtue of its petrographic composition, might actually be weak as a result of abnormal fracturing. If time had permitted multiple testing, the correlation probably would have been more significant. The correlation is made more evident by arbitrarily dividing the samples of each diagram into three groups, on the basis of their vitrinite content, and averaging the compressive strengths within each group. The three groups are: 70-80%, 80-90% and 90-100% vitrinite. The relative amounts of exinite and inertinite are ignored. The groups are delineated by the brackets at the right of each diagram and the average compressive strength is indicated at the bracket. These averaged strengths for the three column samples are compiled in Table 4. The comparison clearly shows the inverse relation between percent vitrinite and compressive strength for all three samples. In addition, the table reveals that the Florence coal (IV 29) has slightly superior briquetting qualities, but this cannot be explained by any apparent petrographic differences.

TABLE 4

Average Compressive Strengths for the Briquets within the 70-80%, 80-90% and 90-100% Vitrinite Groups of Column Samples IV 27, 28 and 29

Column Sample	Averaged Compressive Strength, psi		
	Group 90-100%	Group 80-90%	Group 70-80%
IV 27	5,600	6,900	7,700
IV 28	6,000	6,500	7,200
IV 29	6,600	7,700	8,000

Cursory Investigation of the Influence of Rank and Blending on Briquet Quality

The influences of rank and of blending non-coking materials with high volatile A bituminous coal, on briquet quality, are summarized in Table 5. The results are not detailed, and the data are only of a qualitative nature since the samples were not compression tested but were only examined microscopically.

Samples falling within the rank range of low volatile to high volatile B bituminous produce good to excellent briquets, but the extreme high and low rank briquets are only poor to fair. The subbituminous briquets swell and crack when exposed to humid atmospheres. From this limited work it appears that there is at least a rough correlation between briquet quality and the plastic properties of coal as determined by plastometers and dilatometers.

TABLE 5

Influence of Rank and Blending on Briquet Quality

Description of Sample	Location	Rank	Quality of Briquet
#4 Mine	Canmore, Alberta	Low volatile to semi-anthracite	Fair
Pocahontas	West Virginia	Low volatile	Good
Bellevue #1	Bellevue, Alberta	Medium volatile	Excellent
Tracy Seam	Cape Breton, N.S.	High volatile A	Excellent
Chilton	West Virginia	High volatile A	Excellent
Sunnyside	Utah	High volatile B	Excellent
#2 Seam	Illinois	High volatile C	Fair-good
Brilliant #8 Mine	Brilliant, Wyoming	Subbituminous	Poor
Harbour Seam and Canmore #4, 50-50 blend			Excellent
Harbour Seam and Coke Breeze, 50-50 blend			Fair-good

Table 5 also shows that high volatile A bituminous coal can be successfully blended with high rank coal, and, to a lesser degree, with coke breeze.

Effect of Removing Briquets from the Mould at 250°C.

Briquets removed from the mould at 250°C swell and crack as a result of the internal pressure developed mainly by the trapped creosote vapours, and by the lack of confinement at the high temperatures, but they still maintain a fairly high degree of coherence.

CONCLUSIONS

This laboratory investigation indicates certain desirable conditions for producing strong briquets in a cylindrical mould: (1) an optimum briquetting pressure between 4 and 10 tons per sq in., since the briquets jam in the mould at higher pressures; (2) a temperature of 250°C, at which the coal is sufficiently plastic to attain a degree of packing such that very little void remains between particles; (3) a 5% addition of creosote oil, which substantially improves the bond between particles; (4) a high percentage of fine particles, as the compressive strength varies inversely with the particle size; and (5) a means of confinement while the briquets are cooling. Briquets produced under these conditions are much stronger than briquets prepared with an asphalt binder. Additional factors which influence briquet quality are petrographic composition and rank. In the high volatile A bituminous range investigated, it was shown that a 20% reduction in vitrinite increases the compressive strength by approximately 1,000-2,000 psi. The most desirable coals with respect to rank fall between high volatile B and low volatile bituminous; in other words, the best briquets are obtained from those coals that ordinarily show some degree of fluidity in the carbonization range.

Microscopic examination of polished surfaces of briquets is a useful technique for studying the degree of packing, the nature of the contact between particles, and the extent of micro-fracturing. A knowledge of these factors is important in evaluating the relative effects of different briquetting conditions. Furthermore, a qualitative assessment of briquet strength can be made from a microscopic examination.

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