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RESEARCH ARTICLE

STUDY ON THE INFLUENCE MECHANISM OF DEHYDRATION AND DEVOLATILIZATION ON VARIOUS FORMS OF SULFUR IN COAL WITH DIFFERENT METAMORPHIC DEGREES

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Abstract

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Dehydration and devolatilization on the behavior and phase transformations of various sulfur forms in coal with different metamorphic grade. The nature of sulfur in coal includes and pyritic, sulfate, organic, and elemental sulphur, and the fate of these forms during thermal processes determines the merits of desulfurisation. It was determined through thermal experiments conducted on coals of different metamorphic classes (lignite, bituminous, anthracite) that the dehydration process has a modest but measurable impact on sulfur oxidation with major changes recorded in the high-density coals. A general observation, however, was that devolatilization had a significant effect in the low rank coals such as lignite where higher volatility resulted to higher sulfur release at the pyrolysis stage. In this regard, the study demonstrates that organic sulfur transformations are most important in low- and high-density regions of low-rank coals and that sulfite sulfur has the least amount of response to dehydration. Sulfate sulfur however showed a significant decrease after dehydration particularly in high density part of anthracite. These results propose new knowledge on sulfur change reactions for coals, which can guide advanced desulfurization suggestions to the coal industry[1].

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Introduction:-

Sulfur content in coal presents a significant influence for coal processing and many metallurgical applications. Pyritic, organic, sulfate, sulfite sulfur in coal can answer differently the effects of thermal processes including dehydration and devolatilization which are required in minimizing the levels of sulfur in coal.

This work investigates the impact that dehydration and devolatilization have on the sulphur forms in coals of different metamorphic grades for better understanding of the processes of desulfurization and optimization of the utilization of coal in metallurgical industries.

Many sulfur removal processes have been studied and applied in practice using specific methods for each of the mentioned sulfur types. Pyrite sulfur can always be treated mechanically in the ways with washing or flotation while chemical treatments consist of leaching and oxidation for treatment of pyritic as well as organic sulfur. For high-sulfur coals, the high-temperature processes like thermal cracking are useful in dissociation of sulfur compounds into gaseous sulfur which can then be collected for the sulfur subtraction. Desulfurization at high temperatures has many processes such as dehydration and devolatilization. Drying affects the distribution of moisture in coal since

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dehydration tends to increase the density of sulfur within certain domains in coal. Devolatilization physically decomposes organic compounds whereby some organic sulfur is transformed to gaseous form, and thus reducing the amount of organic sulfur in the coals depending on temperature and time.

Essential for the determination of the efficiency of desulfurization methods that are important in the management of sulfur and its forms brought by dehydration and devolatilization. It also presents the idea that different kinds of coals mixed for its sulfur content and other components for the type of response or reduction of S release can be tempered by the temperature and time of the treatment. Broad objectives of this study are to evaluate the influence of compositional alterations based on dehydration and devolatilization on sulfur species in coals with reference to metamorphic grade to devise advanced desulfurization approaches.

Enhanced models for sulfur determination and cleaner methods of desulfurization make effective utilization of sulfur-containing coals for practical use as a material, for example for steel manufacturing where the sulfur content affects both the product quality and the environmental effect.

(A) Yongchuang Coal Washing Plant (Lignite), Inner Mongolia - characterized by low-rank coal with significant moisture content.

(B) Shanxi Lu'an Group (Anthracite) - representing high-rank coal with low volatile matter and high carbon content.
(C) Luizhi Coal Sample - pending arrival, expected to offer insights into medium-rank coal.

Experiments and methods

Sample Collection and Preparation

The coal samples used in this test came from three kinds of coal samples of different coal types in three provinces of Guizhou, Shanxi and Inner Mongolia, including lignite, anthracite and coking coal, with relatively high sulfur content, which are high sulfur coals, and the coal samples are as follows:
(A) 27km Yongchuang Coal Washing Plant, Lashinzhong Street, Hainan District, Wuhai City, Inner Mongolia Autonomous Region (lignite)
(B) Liyang Coal Processing Plant of Heshun Liyang Coal Co.)
(C) Sixin Coal Mine, Liuzhi Special Zone, Guizhou (coking coal)

A total of three collected coal samples (A, B, C) were individually weighed, and the weights of each type of coal were measured and recorded, and then labeled. According to the measured weight to determine the selection of the appropriate weight of the coal samples for sieving, floating and sinking and subsequent experiments, to complete the preparatory work before the test. The 50~0.5 mm samples were sieved; the 50~0.5 mm samples were divided into 6 density intervals of <1.3, 1.3-1.4, 1.4-1.5, 1.5-1.6, 1.6-1.8, and >1.8 for the full-grain floatation and sinking test, and then dried and weighed, and then divided into 2 parts, one of which was ground and made to be used in the industrial and elemental analyses, and the other part of the full-grain samples was retained for the subsequent tests.

The morphology of sulfur in the three samples and their average distribution in different density grades

In this study, the morphology of sulfur and its distribution across various density grades were analyzed for three coal samples from different origins:

1.Sulfur Morphology

Table 1:- EDS energy spectrum element content statement for different density levels for the three samples A, B, C.

	<1.3 density class (%)			**>1.8 density class (%)**		
Element	A	B	C	A	B	C
N	49.398	46.572	37.222	25.374	40.024	36.818
O	46.708	48.505	55.050	68.729	46.231	50.251
S	2.146	4.874	4.072	2.274	7.443	5.828
Fe	1.748	3.049	3.656	3.623	6.302	7.103
Total	100.000	100.000	100.000	100.000	100.000	100.000

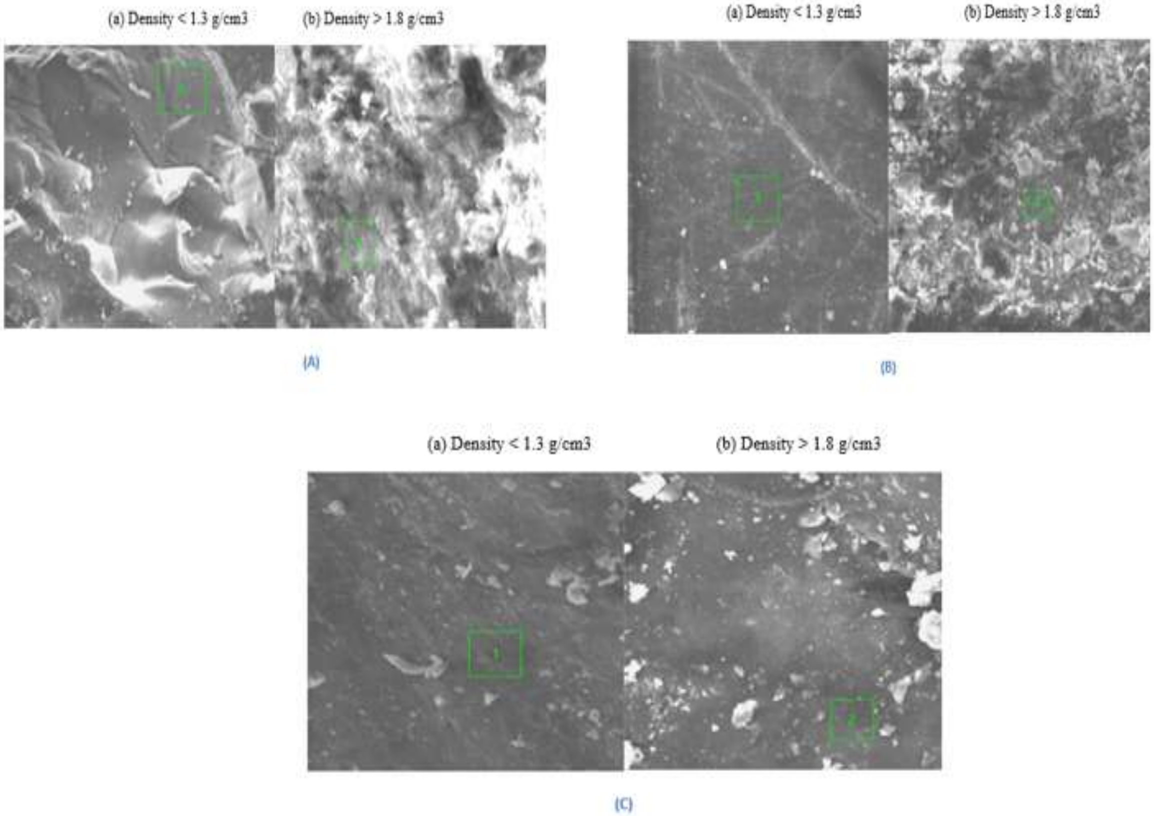

Figure 1:- SEM-EDS scan of different desity levels in the three samples.

SEM-EDS data for Guizhou Liuzhi coking coal at <1. 3 and >1. 8 g/cm³ densities are shown in Figure1 and Table1. The ash content is lower while the number of minerals is fewer in low-density (<1. 3 g/cm³) coal, unlike high-density (>1. 8 g/cm³) coal which has more pronounced white mineral particles and higher ash content[2]. As density increases, EDS analysis demonstrated an increase in S and Fe, particularly Fe, whereas a decrease in N,O,S contents were observed. This suggests that there is pyrite rich high-density coals with less organic sulfur compared to low density ones. Mineral content observed and the way sulfur was distributed could be due to some specific geological conditions under which mines existed in Guizhou area.

Shanxi Lu'an anthracite was subjected to SEM-EDS analysis with the results displayed at densities of <1. 3 g/cm³ and >1. 8 g/cm³. In high-density (above 1. 8 g/cm³) coal, large white mineral particles stand out against a low-density (<1. 3 g/cm³) which appears more evenly distributed and smaller minerals are present in greater amounts. The EDS data reveals that high-density coal has lower levels of N, O, S but higher Fe while low density ones have less organic sulphur but more inorganic sulphur. High-density anthracite shows that it is richer in pyrite sulfur formed differently than carbonized coal while low density one is highly composed of organic matter which could be accompanied with some pyrites for instance[3].

In the Inner Mongolia yongchuang lignite SEM-EDS data, this work uses a density class of less than 1.3 and more than 1.8 to illustrate this statement[4]. The SEM images show that <1.3 density lignite has a smooth surface with limited presence of mineral particles while >1.8 density lignite has higher distribution of white mineral particles indicating that there is higher concentration of minerals and better inorganic sulfur content[5]. Therefore, increased Fe and rather constant S content during the rise in density indicate that high-density areas are rich in inorganic sulfur specifically pyrite, This is contrasted with coking coal and anthracite, which have low organic sulfur but high O contents for low density lignites; hence suggesting that organic sulfur is mainly present in low–density regions of lignites[6].

Density Distribution:

During the coal formation process, various impurities including kaolinite, montmorillonite, and illite clay minerals may become incorporated, resulting in non-uniform density distribution within the coal[7]. In order to more intuitively reflect its distribution law, the full sulfur content and each density level of each coal sample to plot its changes, as shown in Figure 2.

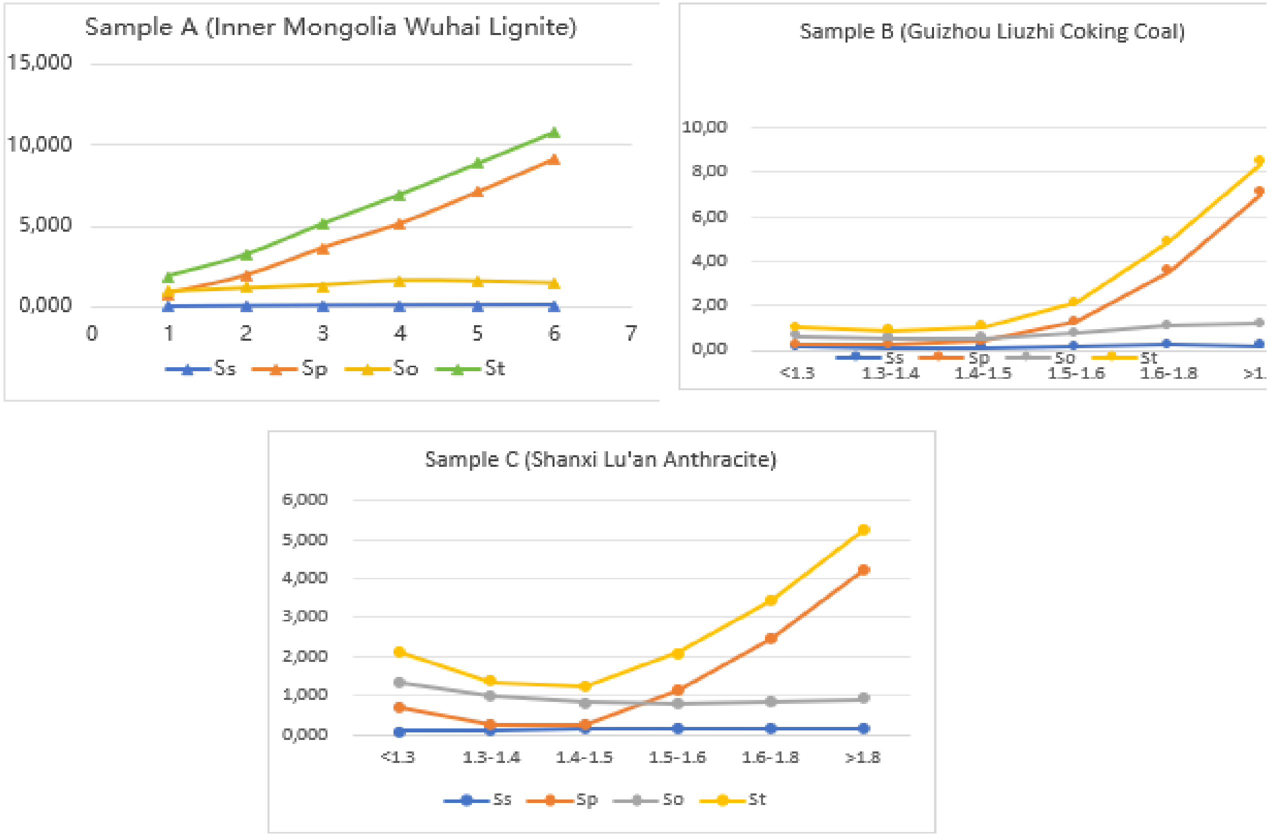

Figure 2:- Distribution of full sulfur content in each coal sample at different density levels.

The result of this research for the three samples of Sample A, Sample B and Sample C shows how sulfur content changes with density fractions. Although pyritic sulfur content rise with density in all samples, high density category of coals contain more of this type of sulfur which is normally associated with mineral matter like pyrite. Such trend implies that, to effectively lower the overall sulfur concentrations, higher density fractions may have to undergo more rigorous S mitigation techniques. Organic sulfur, on the other hand, have variations with coal type and it is predominantly located at lower to medium range density, but it is difficult to be extracted because of its interaction with the matrix of the coals. Concentrations of sulfate sulfur are still below the tested densities and do not significantly increase the overall sulfur content. As a result, proportions of high-density fractions are highest in total sulfur percent in both lignite and coking coals contributed by pyritic sulfur. These results point to increased effectiveness of such specific treatments as aimed desulfurization and emphasize the desirability of higher density cok fraction coal to remove pyritic sulfur, which remains crucial to environmental standards and protection of industrial equipment from corrosion deterioration.

Determination method of dehydration, devolatilization and different forms of sulfur

Determination of the dehydration, devolatilization, and forms of sulfur in coal is very vital in describing its chemical properties and behavior. Dehydration is determined by drying the sample at 105°C until constant weight is reached, measuring moisture content according to ASTM D3173[8]. Devolatiles are determined by heating coal to 950°C under an inert atmosphere for determination of volatile matter according to ASTM D3175. The following are some of the techniques used in the analysis of sulfur: Total sulfur content ASTM D4239 is determined by coulometric titration; Sulfate and sulfite sulfur is determined using methods such as turbidimetric methods and atomic absorption spectrophotometry. Organic sulfur can then be calculated by difference between the measured sulfate and sulfite sulfur and total sulfur. These analytical methods, therefore, bring out information that gives insight into the composition of the coal in terms of processing and use[9]

Results and Discussion:-

Effects of dehydration on sulfur in each density level of the three kinds of coal

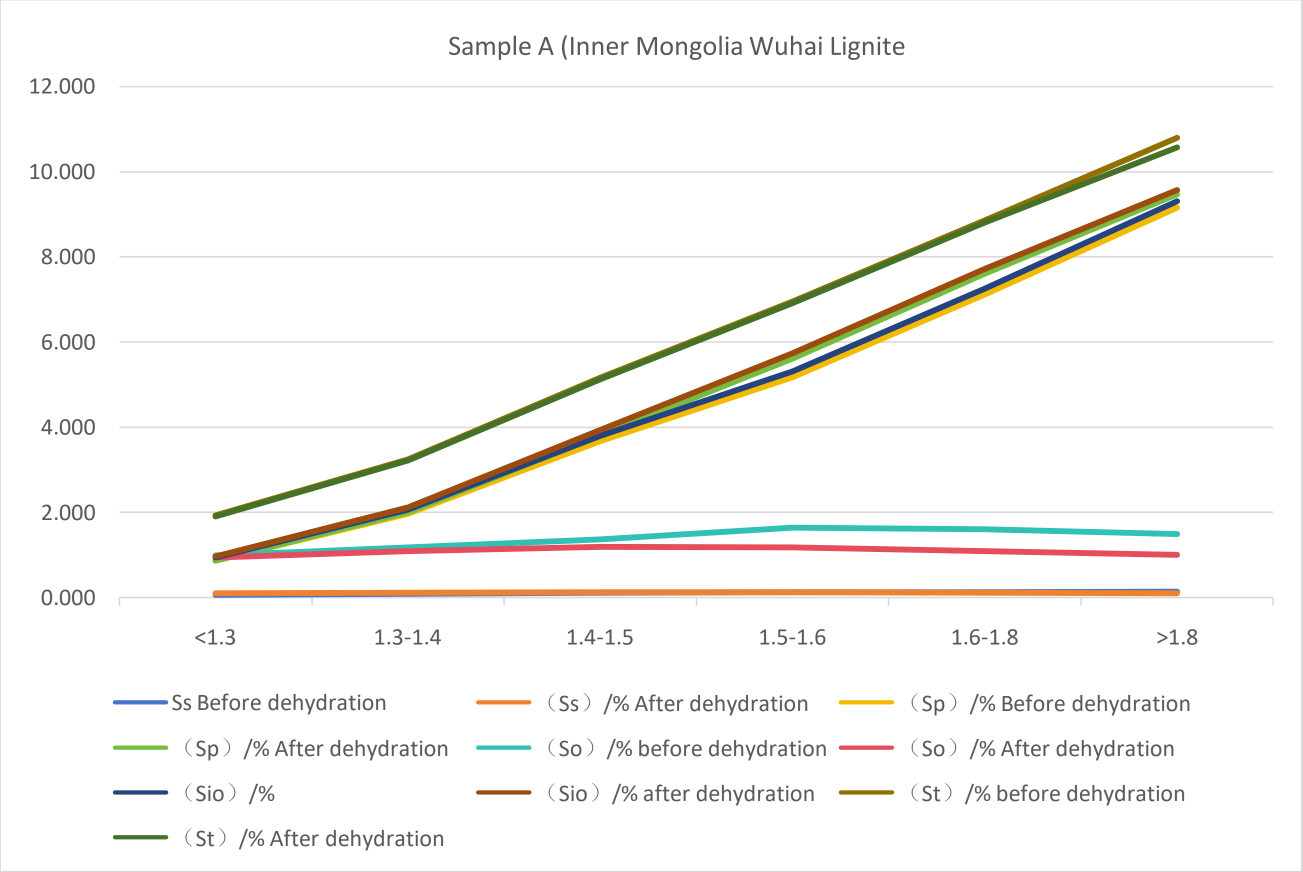

Figure 3:- The contents of organic sulfur and inorganic sulfur in sample A before and after dehydration.

According to the data of sample A (Inner Mongolia Wuhai Lignite), the content of sulfur in different forms in different density fractions has significant difference before and after the dehydration process. The total sulfur content they defined as St also goes up with density: the lighter the sample, the lower St, from 1.94 wt% in the fraction with density lower than 1.3 g/cm3 up to 10.79 wt% in the fraction denser than 1.8 g/cm3 before dehydration. Subsequent to dehydration there is a slight fall in the total sulfur in all the fractions possibly because of reduction in the organic sulfur (So) which also is reduced after dehydration, therefore dehydration really strips off some volatile organic sulfur compounds. As_FOR (ryA) shows increased values of pyritic sulfur (Sp) content with density, it can be concluded that denser coal fractions contain more mineral-bound sulfur. In a subsequent step of the analysis, Sp rises slightly, which may be explained by concentration effects arising from dehydration. Sulfate sulfur (Ss) still remains quite low but fluctuates somewhat, and inorganic sulfur (Sio: Ss + Sp) also rises with density and increases still further after dehydration. Summarizing, according to the data received it is established that studied density fractions of this lignite have higher sulfur content due to increase of pyritic and inorganic sulfur, and dehydration decreases organic sulfur, while slightly concentrating inorganic forms [10].

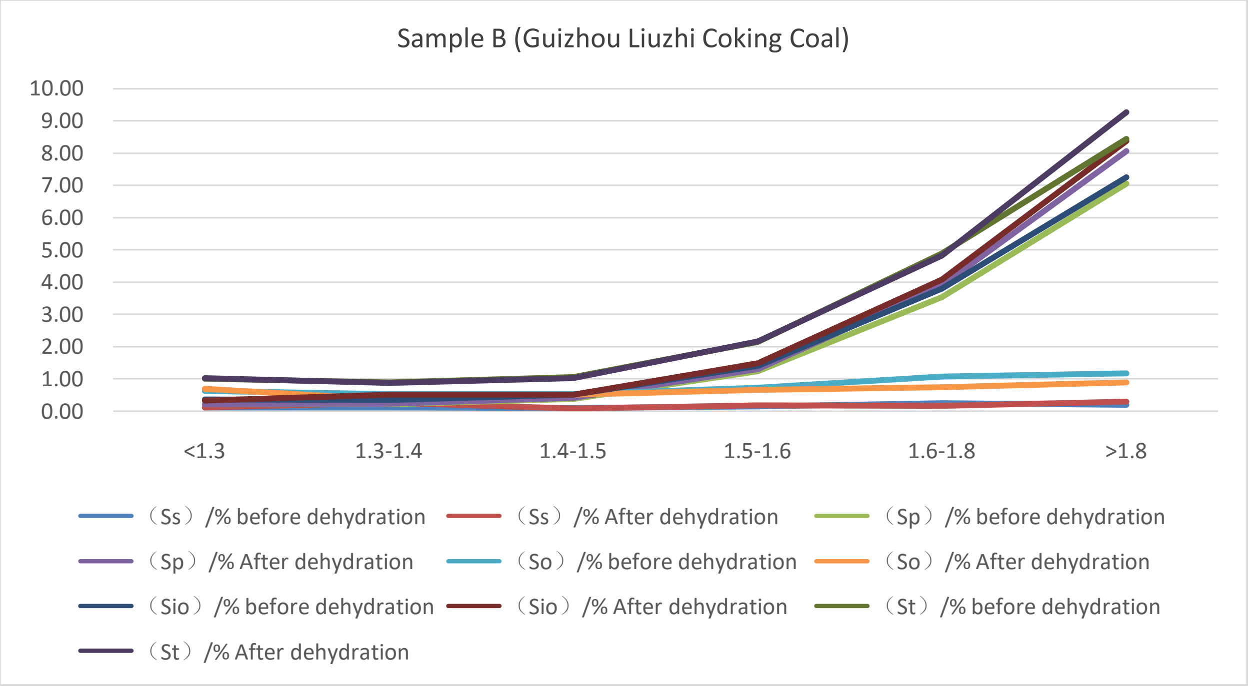

Figure 4:- The contents of organic sulfur and inorganic sulfur in sample B before and after dehydration.

The analysis of Sample B (Liuzhi Coking Coal from Guizhou) shows that the increase of S content with density fractions is characterized significantly for pyritic sulfur (Sp) and inorganic sulfur (Sio). Before dehydration, total sulfur (St) content increases from 1.00% for the lightest fraction <1.3 to 8.45% for the heaviest fraction >1.8. With combined dehydration and density gradient, the total sulfur content rises even higher in the floats, to 9.275% in >1.8 fraction. Dehydration has been found to decrease organic sulfur (So) in all density fractions but presumably because some organic S may be volatile and was lost during drying; inorganic S forms are reported to increase with removal of moisture possibly because these minerals concentrate with drying. These trends indicate that for a given sample, the heavier coal fractions have a higher inorganic sulfur – especially pyritic sulfur, which affects the processing and utilization of coal, as the content of sulfur increases the output of sulfur dioxide during combustion [6].

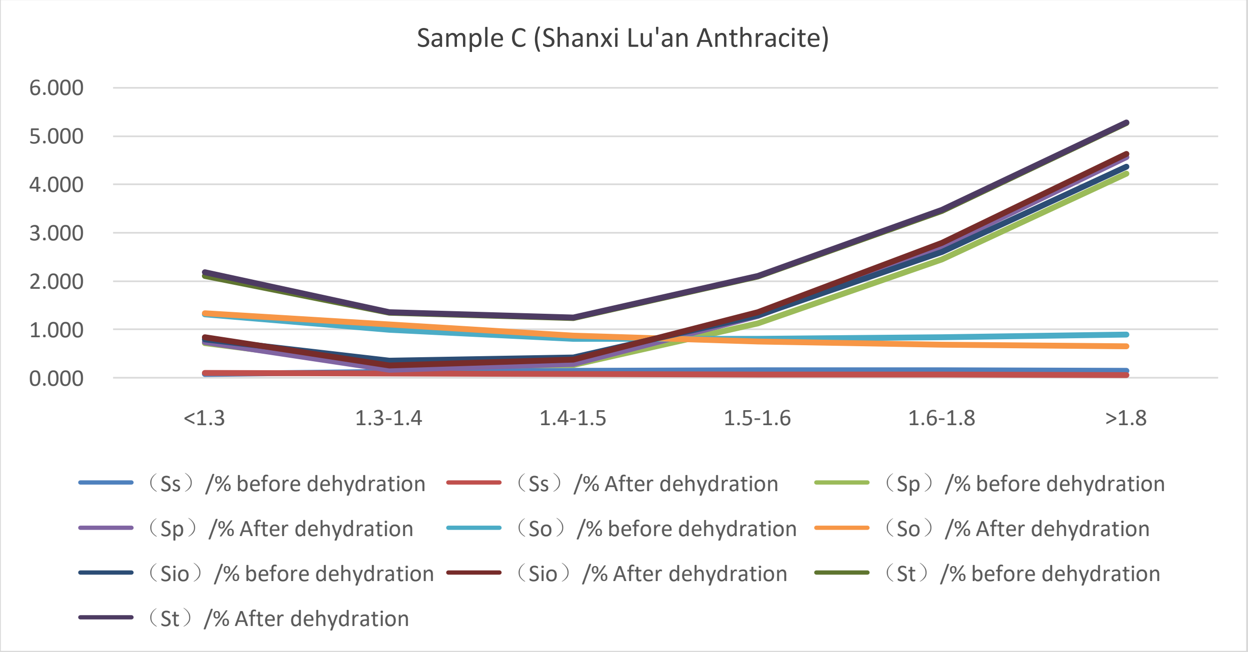

Figure 5:- The contents of organic sulfur and inorganic sulfur in sample before and after dehydration.

The data of Sample C Shanxi Lu'an Anthracite Coal is used and it is observed that sulfur is dependent upon density fraction and impacts the degree of dehydration. Prior to dehydration, total sulfur content (St) also rises with density where St = 2.11 % in the lightest cut (<1.3) and St = 5.27 % in the heaviest cut (> 1.8). As expected, the principal form of sulfur, which is the total sulfur, does not change significantly or only shows slight variation with some fractions even after dehydration. Pyritic sulfur (Sp) increases with density, from 0.713% in the <1.3 fraction to 4.220% in the> 1.8 fraction before dehydration, and from 1.780% to 2.540% after dehydration; hence, higher density fractions contain more minerals-bound S. Organic sulfur (So) is slightly declined after the dehydration in most of the fractions, which allow concluding that the dehydration leads to a decrease of organic sulfur, perhaps due to the evaporation ability of some of the compounds. Total inorganic sulfur (Sio), consisting of sulfate sulfur (Ss) and pyritic sulfur (Sp), rises with density and experiences a relatively slight rise following dehydration possibly influenced by concentrating impact of water evaporation. Combined, these results show that the higher density fractions of this anthracite coal contain more sulfur in the inorganic forms and that dehydration increases the pyritic and inorganic S but slightly reduces the organic S. This has implications for coals utilization because inorganic sulfur is released as sulfur dioxide during combustion if the content is high [11].

Comparing the sulfur content of the three samples: Sample A, Sample B and Sample C show differences related to ranks and density fractions of coals. Sample A, a lignite, demonstrates the highest total sulfur content, and in the density higher fractions, the total sulfur (St) increases from 1.94% to 10.79% before dehydration. This high sulfur content is attributed to a high content of pyritic sulfur (Sp) and inorganic sulfur (Sio) which show a corresponding rise in density. In Sample A, the dehydration causes So to decreases a little and inorganic sulfur forms slightly because of the loss of moisture. Sample B; the coking cool has a relatively small increase in total sulfur content with density ranging from 1.00 % to 8.45% before dehydration as shown below. According to the cases, the pyritic sulfur is the most predominant form that rising after dehydration, this manifest that the higher density fraction have more sulfur associated with mineral forms, while the organic sulfur is declined, this is due to loss of volatile compounds after dehydration. As seen in the relative analyses above, **Sample C**, the anthracite, has the least amount of total sulfur with the St raising from 2.11% to 5.27% before dehydration. Pyritic sulfur in Sample C increases with density but the total sulfur contents are still lower than that of Samples A and B Dehydration change Sample C by increasing inorganic sulfur slightly and reducing the organic sulfur in the sample as well in the other samples.

In conclusion, catalyst develops from the comparison that the lower-rank coals like samples A (lignite) contain higher weight percentage of S, especially in the form of inorganic S than the higher-rank coals like sample C (anthracite). Each of the dehydration processes mentioned usually decrease organic sulfur slightly while increasing inorganic sulfur across the board, however the degree of shift depends on the type and density fraction of the coal, and when used in practical applications it may require control emission measures with respect to sulfur [12].

Mechanism of influence of dehydration on sulfur in coal with different degrees of metamorphism

The changes of the total sulfur content before and after the dehydration are rather small for all three coals; however, there are certain oscillations in the high-density region of Guizhou Liuzhi coking coal; whereas the fluctuations of the Shanxi Lu'an anthracite and Inner Mongolia Yongchuang lignite is almost negligible. This means that moisture hardly change the release and transformation of sulfur[13].

It is observed that the organic sulfur content of Guizhou Liuzhi coking coal rises and falls after dehydration especially in low density and high-density region. Organic sulfur in Shanxi Lu'an anthracite declines with all density classes to indicate how moisture influences organic sulfur on higher density coal where middle to high density segment received a stronger impact[14]. Yongchuang lignite from Inner Mongolia shows the low-density part has a higher value of organic sulfur and a drastic decrease in the high-density part under conditions of dehydration. It has been found that organic sulfur of high-density lignite is greatly influenced by dewatering processes, thus possibly affecting total sulfur[15].

Dewatering also affects sulfate sulfur, especially in Shanxi Lu'an anthracite and Guizhou Liuzhi coking coal; a lower sulfate sulfur content in anthracite implies that moisture reduction might decrease sulfate sulfide. Sulfite sulfur is relatively stable against dewatering, effectively modified in vertical density in higher deteriorated coals such as Inner Mongolia Yongchuang lignite. In general, dewatering influence organic and sulfate sulfur prominently, and this is pronounced particularly in low- and high-density areas while sulfite sulfur is affected with a dewatering cycle depending on the degradation level of coals[12].

The way the dehydration affects the sulfur content in the coals depends on the metamorphic rank of coals involved. In less-metamorphosed coals, such as the lignite coals, dehydration is more prominent and gives rise to marked changes in organic sulfur in the high-density sample fraction, for instance. On the other hand, in the coals with higher metamorphic rank such as the Shanxi Lu'an anthracite, effect of dehydration on the S content was insignificant as seen in small reductions in both the organic S types especially in the mid- and high-density components.

This means that the mobile and chemically reactive behaviour of moisture is significantly more important in less metamorphic coals which releases and transforms the sulfur compared to the rather small effect of dehydration existing in highly metamorphosed coals. Combined, the impact of dehydration on sulfur is even more enormous in coals of less metamorphism, which means that the macrologic organization of the coal also plays a role in the behavior of moisture or S-content[15].

Effects of devolatilization on sulfur in each density level of the three coals.

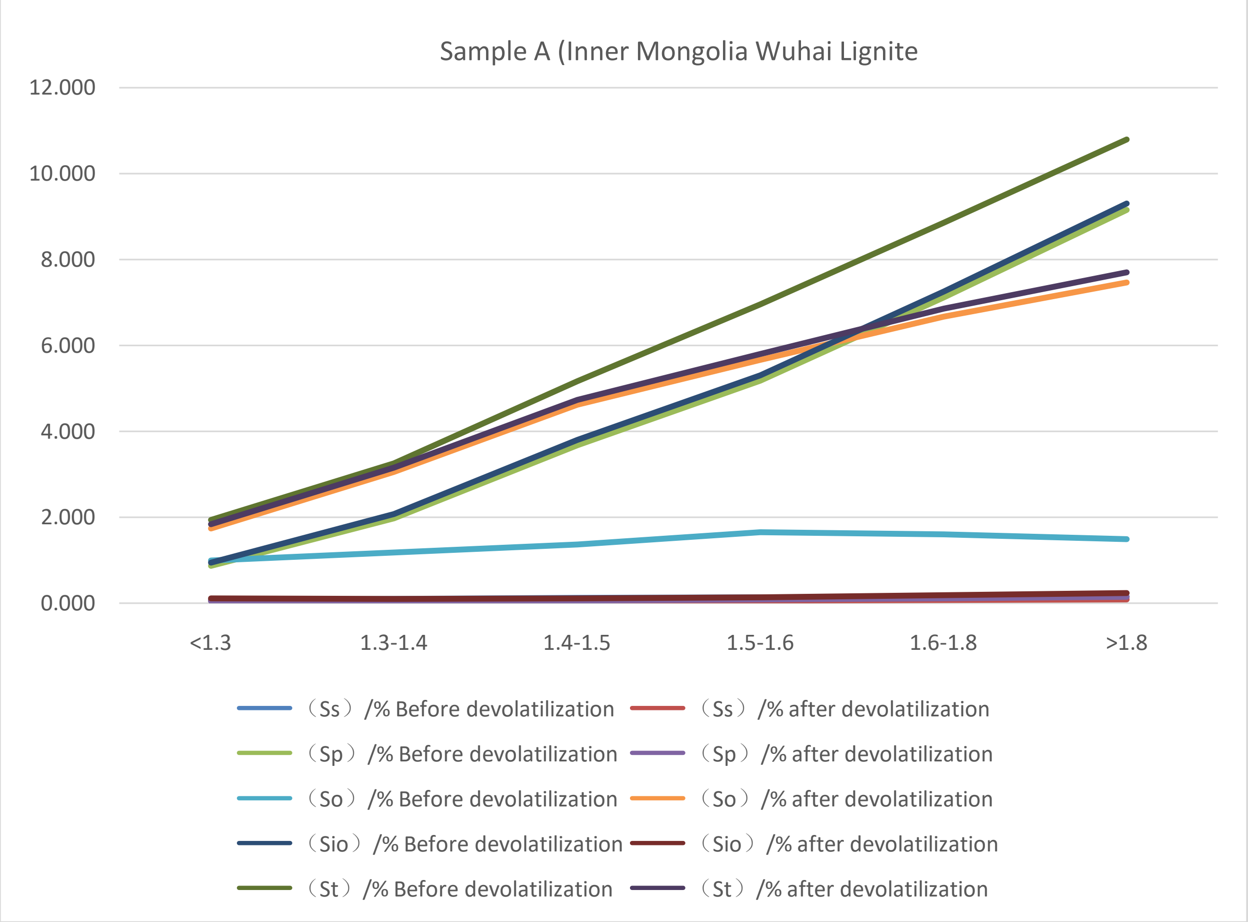

Figure 6:- The contents of organic sulfur and inorganic sulfur in sample A before and after devolatilization.

The sample A which is (Inner Mongolia Wuhai Lignite) reveals the fact that sulfur contents has been highly affected by devolatilization for all density fractions before and after. Inorganic forms of sulfur such as sulfate sulfur (Ss) and pyritic sulfur (Sp) dominated the overall sulfur total content (St) and reserves (Sio which consists of Ss and Sp) of 0.94% for the lightest fraction (<1.3) and 9.299% for the heaviest fraction of (>1.8) existed before the devolatilization process. However, after the devolatilization process the inorganic sulfur increased only between 0.105%-0.233% to all density fractions. On the other hand, there was a massive increase in organic sulfur (So) content after devolatilization from 0.996% to 1.735% particles which were lighter in the lowest percentage while heavier particles contained up to 7.467%.

This change indicates that during devolatilization which is a process where oxygen is completely absent and the coal is heated causing volatile matter to exit the coal structure, such inorganic sulfur compounds as pyrite can either rot or combust to sulfur gases H2S or SO2 therefore minimizar the residual sulphur content within the coal matrix. The observable rise in organic sulfur content in coal after devolatilization can be assumed to be caused by concentrating; because of the lost of volatile parts, the leftover mass becomes high in organic average sulfur contents[16].

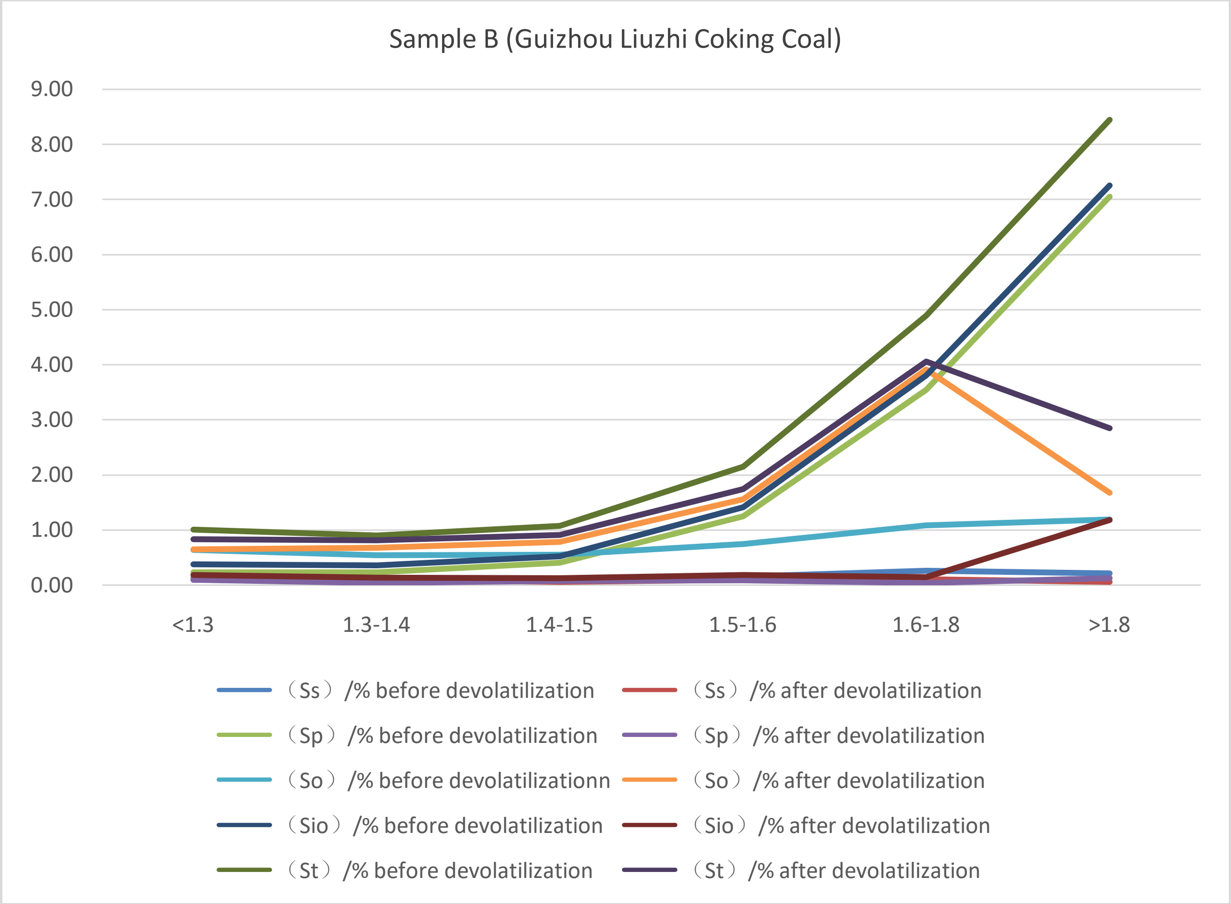

Figure 7:- The contents of organic sulfur and inorganic sulfur in sample B before and after devolatilization.

The data for Sample B (Liuzhi Coking Coal from Guizhou) indicates a notable variability on sulfur amount for separate density fractions before and after devolatilization. There are two inorganic sulfur forms, sulfate sulfur (Ss) and pyritic sulfur (Sp), which initially surround a large quantity of sulfur total (St), especially for high density fractions. For instance, the >1.8 density fraction indicates that before devolatilization, 7.26% of Sio, the sum of Ss and Sp, is present in the inorganic form (Sio). However, after devolatilization, the amount of inorganic sulfur present in any of the density fractions is reduced drastically to 0.14% for the 1.6-1.8 fraction and 1.17% in the >1.8 fraction. As for the organic sulfur, its (So) content is known to increase significantly post-devolatilization, especially for the high-density fractions, rising from 1.08% to 3.91% in the 1.6-1.8 fraction and from 1.19% to 1.67% in the >1.8 fraction.

These changes have important implications for coal utilization and environmental impact. The reduction in inorganic sulfur suggests that devolatilized anthracite coal may produce fewer sulfur dioxide emissions during combustion, which is beneficial for meeting emission regulations. However, the increased proportion of organic sulfur may affect combustion characteristics and requires consideration in designing pollution control strategies, as organic sulfur is more challenging to remove through conventional cleaning processes.

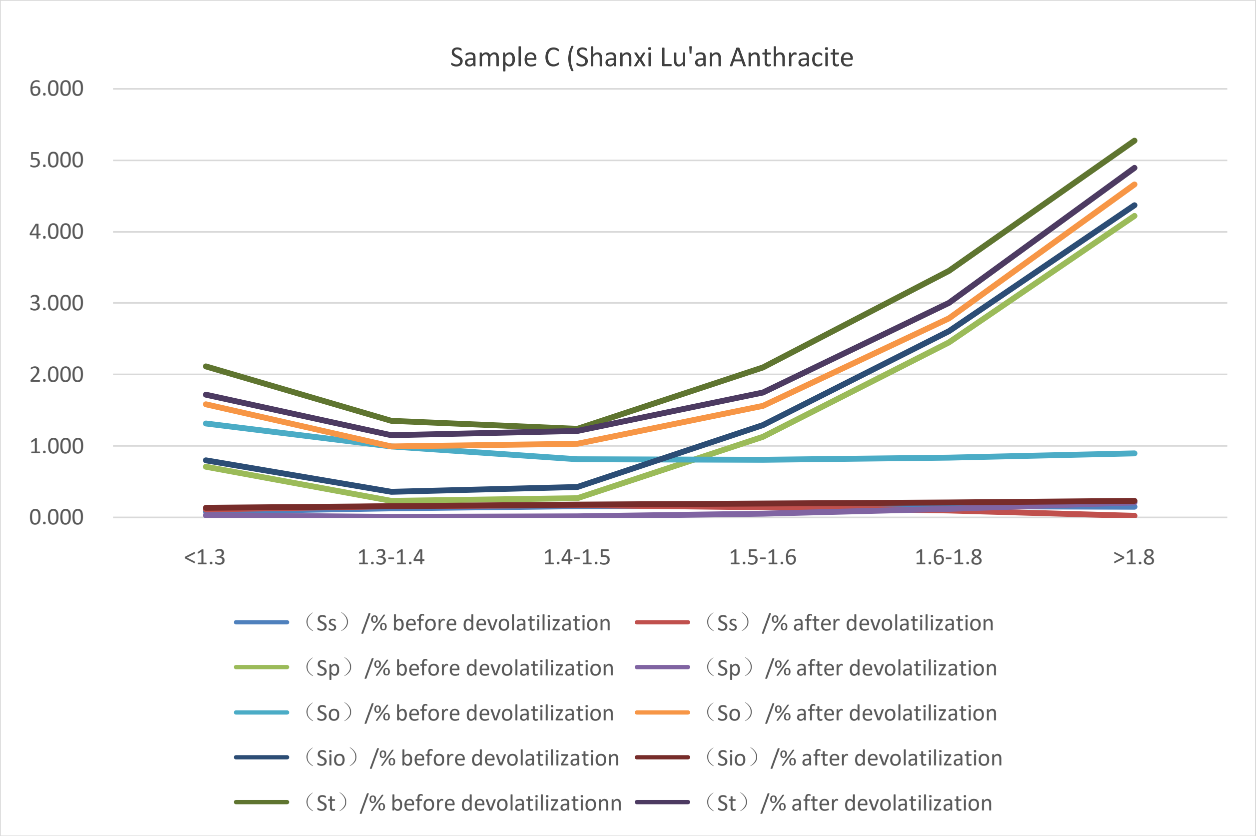

Figure 8:- The contents of organic sulfur and inorganic sulfur in sample C before and after devolatilization.

Data pertaining to Sample C (Shanxi Lu'an Anthracite) show strong changes related to the different density fractions of sulfur content prior to and after devolatilization. Involvement of Sio, the sum of Ss and Sp: Solid sulfate Sio, and pyritic Sio, which are inorganic Sio forms in the total Sio content before devolatilization, unfortunately, dominated in greater density fractions, for example, above 1.8 density Sio fractions where Sio (Sio = Ss + Sp) Sio was about 4.370% volumetrically before the devolatilization process.

Instead of only brute force or harsh chemicals to remove sulfur content in crude oil or heavy oil fractions, these removal constituents can also be removed through exposure to time and heat. The sulfur in the >1.8 density fraction volume remained comparatively intact, with the content declining to as low as 0.137% in the <1.3 fraction and 0.228% in the >1.8 fraction after the devolatilization procedure.

In other words, almost a 0.57% rise occurs with increase in organic sulfur content in the <1.3 fraction after the heating process, while from 0.900% to 4.662% organic sulfur content is observed in the >1.8 fraction, indicating substantial changes. It can be inferred that within this timeframe of the devolatilization process, H2S and SO2 gases are always released, and any existing inorganic S bound sulfur compounds are decomposed for primary coal organic cultures.

The overall S content, which is referred to as the total sulfur content St, in coal was reduced for volume fractions across all density fractions after the devolatilization, confirming that the S bounded in organic compounds is increasing volume fractions throughout the entire coal[17].

The results for sulfur content analysis in the three coal samples—Sample A (Lignite of Inner Mongolia Wuhai), Sample B (Guizhou Liuzhi Coking Coal) and Sample C (Shanxi Lu'an Anthracite)—show that devolatilization affects the distribution as well as the total amount of sulfur coals of different ranks and densities contain. All samples before dyewater case possess a relatively high content of inorganic sulfur uptight, this is more, and especially pyritic Sp which has been found to rise and become significant due to the density of coal. After dyewater there's quite a bit loss in the nuclear sulfur for every one of the samples as a result of the breakdown of compound which are called sorbent and such gaseous sulfur products as H2S and SO2 are created. On the contrary organic So sulfur content seems to rise after dyewater but most likely as a result of concentration effects whereby loss of volatile matter and inorganic sulfur is observed as well as new organic sulfur species possibly being formed in the course of thermal treatment. The sulfurs total also IC older post devolatilization suggesting that at the end different industrial forms of sulfur have been lost. Such changes are seen most strongly in lower rank coals lignite sample A and few such in the answer rank coals anthracite sample C.

The findings highlight that devolatilization can effectively reduce inorganic sulfur content in coal, potentially lowering sulfur dioxide emissions during combustion. However, the increased proportion of organic sulfur may influence combustion characteristics and necessitates consideration in pollution control strategies, as organic sulfur is more challenging to remove through conventional cleaning processes[18].

Mechanism of influence of devolatilization on sulfur in coal with different degrees of metamorphism

The effect of devolatilization mechanism on coal's sulfur contents is a function of both the coal's degree of metamorphism and the density chosen for the investigation. Devolatilization—removing the volatile components off coal by heating—affects sulfur in fundamentally different ways among the different coal types of varying coalification.

For high rank, high-density coals like Shanxi Lu'an anthracite, which significantly experienced coalification, devolatilization predominantly affects the inorganic sulfur forms such as pyrite sulfur. Because of increasing concentration through volatile matter removal, devolatilization usually enhances the pyrite sulfur content and, in this manner, increases the inorganic sulfur content. This is because the high-density section of anthracite is very rich in minerals, which include iron sulphides that are not very sensitive to volatile removal[8].

The results showed that the devolatilization process might lead to both organic and inorganic sulfur transforming relatively balanced in this grade of coking coal, which was of medium density. At the same time, both forms of sulfur change together[19]. This section usually consists of a mixture of the organic fraction and minerals in an average state, hence sulfur content in both forms shows changes with heating. This may also have driven such partial conversions of initial organic sulfur to inorganic forms such as sulfate or sulfite sulfur, depending on the initial composition of coal.

Devolatilization would have a great impact on organic sulfur for low-density coals, especially for lignite from Inner Mongolia Yongchuang. Lignite is low with respect to metamorphism degree, which provides a large amount of volatile compounds, including organic sulfur. Devolatilization involves the process of mass loss due to the volatilization of components that may belong to different species, thus reducing organic sulfur content to a great extent with a little inorganic sulfur content reduction. Generally, the overall reduction of sulfur in lignite after devolatilization is more significant compared with that in coals of higher degrees of metamorphism[20].

It can be concluded that the impact of devolatilization on coal sulfur is strongly dependent on the coal density and rank of metamorphism. High-density coals show an increasing level of inorganic sulfur concentration, medium-density coals display a balanced transformation of sulfur forms, while low-density coals show a large decrease in organic sulfur[9, 21]. Thus, the choice of densities for study should be aligned with the specific goals of the investigation: specifically, high-density sections will be useful to examine the changes in inorganic sulfur, while medium-density sections will shed light on the interplay of organic and inorganic sulfur throughout devolatilization[1].

Conclusion:-

The ash content is seen to rise as the density of coal/energy increases, meaning Guizhou’s Liuzhi coking coal contains more ash content than Shanxi’s Lu’an anthracite, and Inner Mongolia’s Yongchuang lignite. Similarly, the total sulfur also goes up as the density of coal/energy rises.

This trend shows that as the density increases the total sulfur content is high, the organic sulfur has a tendency to decrease and pyrite sulfur has the tendency to increase[21]. Such low-density zones of coal contain low ash and S content while the high-density zone has high ash and S content primarily because the high-density zones contain higher amount of mineral matters and other impurities. Organic sulfur is mainly in the LD, where it is most abundant, but some ID sulfur is also found in the coal.

In contrast, the high-density regions are marked with high levels of pyrite sulfur; for instance, Liuzhi coking coal with enhanced levels of Iron sulfide. The correlation between sulfur content and coal density is rather indirect and depends such factors as fine coal tailings, especially at a density of 1. 40–1. 325_mesh, in which the flotation separation is challenged in minimizing pyrite sulfur content to below 55 g/cm³. Further, sulfur analysed has highly positive and significant correlation with ash analysed since both are determined by the mineral matter of the coal[14].

Desulphurization of water from coal has a negligible effect on the total amount of sulfur, but a strong effect on the organic sulfur and sulfate sulfur in particular in the low density and high-density cuts. Thus, the elimination of moisture can decrease the content of both the main forms of organic and sulfate sulfur, for lignite with very low metamorphic grades and anthracite with high metamorphic grades[9]. Lastly, the elimination has high effectiveness in cutting down total sulfur in coal in that volatile matter is comprised of unstable compounds[1].

This effect is particularly prominent in volatile matter contents of high-volatile coal C that exhibits a high as-received pyritic sulfur content; however, the efficiency of this action reduces in the more metamorphosed coals such as bituminous coal and anthracite where the percentage of stable organic sulfur is high coupled with high pyritic sulfur in the medium to high density bands while the rate of desulfurization has reduced[10].

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