Carbon Black Production from Various Sources by Thermal Cracking Method

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ABSTRACT: Petroleum-based feedstock (PBFS) and Coaltar-based feedstock (CTBFS) were used for the synthesis of carbon black (CB) via thermal cracking method named as Petroleum-based feedstock carbon black (PBFS-CB) and Coal tar-based feedstock carbon black (CTBFS-CB) in a furnace reactor at a temperature of 1800 °C, for utilizing industrial waste products. The obtained distinguish carbon black samples are characterized for determining functional groups, morphology, and surface area using advanced instruments. Further, investigated physical and mechanical properties of obtained different CB samples mixed into the natural rubber. The small clusters morphology is observed in CBs. There are slight changes in spectra peaks and thereno significant new peaks areobserved. The same minerals observed at same theta values in XRD pattern corresponding to PBFS-CB and CTBFS-CB. The tensile strength, modulus 300% and abrasion loss of samples into rubberwere determined as per international ASTM standards. The results revealed that, there are negotiable values observed in both samples due to minimal changes observed in surface area of the CB samples. These samples can be usedfor various applications viz rubber reinforcement, conductivity agent, colouring agent, and ultraviolet screening agent etc.

1. INTRODUCTION

Carbon blacks (CBs) are produced by partial combustion or thermal cracking of hydrocarbons such as petroleum-based feedstocks, coal tar-based feedstocks and spent tyre oil etc. under delimited conditions (Okoye et al.,2021). Approximately 90% to 95% of CBs are produced globally in furnaces using renewable and non-renewable feedstocks. Aromatic oil is produced as a by-product of natural gas and acetylene manufacturing (Cheng et al., 2020). The cost of feedstock accounts for roughly 60% of the entire cost of CB manufacture. Carbon particles are produced in a variety of ways such as AC thermal plasma, vapor thermolysis, pyrolysis, hydrolysis and carbonization (ICBA, 2016). CB is made up of more than 90% of untainted carbon in total composition and generally spherical carbon atoms of colloidal size that fuse together in aggregates (Ciobanu et al., 2016). CBs are produced in agglomerates form by above mentioned methods, which disintegrate during the rubber-stirring procedure (Ikram and Hashin, 2002). In ordinary parameters, the tiniest dispersible unit in the rubber matrix is the tiny cluster. Hence, clusters are frequently perceived as the emphasizing items themselves (Shah et al., 2013). This carbon black is used

as an agent such as thermal conductivity agent, colouring agent, an infraredairing agent and extensively used in printing as coatings, inks, plastics and others (Donnet et al., 2018). Particularly, 89.5% of CB goes into rubber industries, for production of tires (Wang and Yan, 2011). The physical qualities such as tear strength and tensile strength can be improved by incorporation of carbon blackin rubber.CB improves viscidness and the rigidity of rubber and is one of most excellent filler substances commercially available in the market (Chandrasekaran, 2010). CBs are manufactured commercially using a variety of technologies. These are available in the form of various black names such as furnace, lamp, thermal,acetylene and channel black,which were given names based on according their manufacturing procedures (Kato et al., 2018). Thermal black and channel black come in a variety of grades, including N880 and N990, and are utilized in a variety of rubber compounds. Acetyleneblacks (ABs) and lamp blacks (LBs) were developed by the Chinese for use synthetic substances and black ink. AB is a thermal conductive agent using in rubber substances (Bansal et al., 1993). The CB cluster morphology, surface functional groups and particle size distribution of CBs can be tailored during manufacturing methods (IEA, 2007). The particle

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size in micro/nanometres increases outside or exterior surface area and develops crystalline dendritic structure, enhances the reinforcing performance in rubber. The reinforcing performance is generally better when particle size distribution isbelow micro/nanosize (Wang et al., 2003). For large-scale production, selectivity in carbon black qualities has been developed by controlling temperature, residence time, and feedstock-to-air ratio, in certain cases with the addition of coagulation suppressor (Mark et al., 2005). Due to serious environmental consequences such as global warming and crisis in climate, international societies are gradually challenging rubber industries for utilization of renewable resources for carbon black production (Park and Kim, 2000). Therefore, CB production derived from alternative feedstocks such as renewable resources and recycling of waste materials. The industrial process, productiontechniques and composition of renewable feedstock are impacts on the yield, physical characteristics, and chemical properties of CBs (Quan et al., 2018). CB has excellent thermal stability in inert environments, as well as mechanical and electrical conductivity. It is a biocompatible substance that is chemically stable in non-oxidizing environments (Snowdon et al., 2014). Year-over-year rise in global demand for new automobiles has resulted in an increase in tyre manufacturing and tyres destined for waste. The rubber tyre's service life is finite, and is possible to re-treat them to extend their life (Rodgers, 2015). A few research articles related to the manufacturing of CBs from various petroleum feedstocks are briefly discussed. Rubel (1970) prepared amorphous form of carbon black from petroleum oil for automotive tires using combustion method. Kaminsky et al. (2019) used synthetic and natural rubber as a feedstock for production of aromatic oil and carbon black. The pyrolysis temperature, fluidizing gas type, and gas residence duration in the pyrolysis reactor were all tuned during main products. Pyrolysis tars, clarified oils, aromatic extracts, and vacuum residue were examined by Srivastava et al. (1990) Pyrolysis tar is one of the feedstocks that can be used to make carbon black. The aromatic extract comes next. Roy et al. (1994) prepared oil and carbon black under vacuum pyrolysis method using tyres as feedstocks. Zhou et al. (2018) used leftover tea to make carbon black by physically activating it with steam. The effects of activated carbon yield and pore properties on activation temperature were examined. Due to the breakdown of cellulose and hemicellulose, the yield dropped as the activation temperature was raised. The BET method,temperature plot method and Langmuir equationwere exploited to calculate volume of pore and surface area of CB. As activation temperature rose, more volatile components were released, increasing the specific surface area and micro-pore volume. According to Khalil et al. (2010), CBs were made from organic substances such as Coconut shells (CNS), Bamboo stem (BS), and oil palm (OP). These organic substances were by pyrolysis at 700 ℃The synthesisedCB had porosities that are well-developed and was primarily composed of micro-pores. Lee et al. (2017) exploited thermal treatment with CB in order to make a petroleum-based

binder pitch to enhancepercentage of coking yield and tensile strength of carbon discs.

The goal of this research is to produce CBs from petroleum-based feedstock (PBFS) and coal tar-based feedstock (CTBFS) by thermal cracking method. The impact of feedstock type on Chemical Properties of carbon black and Mechanical Properties of Rubber compound (Natural Rubber Filled with carbon black) are examined. It would be interesting to know how changes in feedstock affect the vulcanizate's physical properties.

2. RAW MATERIALS ANDPREPARATIONMETHOD

2.1 Raw Materials

Petroleum-based feedstock (PBFS) taken from Reliance Industries Limited, Jamnagar, Gujrat, India and Coal tar-based feedstock (CTBFS) taken from Epsilon Carbon, Karnataka, India. These two feedstocks were used for the production of CBs.natural rubber (ISNR 3 CV), zinc oxide (ZnO), stearic acid, carbon black, and MBTS were used for rubber formulations. The characteristics of PBFS and CTBFS feedstocks are provided in Table 1.

Table 1 Characteristics of different Feedstocks

Characteristics		Value	
	Test Method	PBFS	CTBFS
Specific Gravity @15.56°C (gm/cc)	ASTM D 1298	1.08	1.14
API Gravity	ASTM D 1298	0.99	-7.3
Viscosity@ 98.9°C (SUS)	ASTM D 88	89	56
BMCI	Phillips 7317	126	167
Sulphur Content (%)	ASTM D 7679	0.80	0.49
Water Content (%)	ASTM D 95	0.2	0.5

*PBFS: Petroleum based feedstock; CTBFS: Coaltar-based feedstock; API Gravity: American Petroleum Institute gravity, is a measure of how heavy or light a petroleum liquid is compared to water; BMCI: Bureau of Mines Co-relation Index, effectively measures the degree yield of Carbon Black

The viscosity of these two feedstocks performed usingSaybolt viscosity bath for Automatic viscosity timing (Make: Koehler instruments company, inc. USA and Model: SV4000)at different temperature for determining the flow properties for atomization in furnace reactor. It is key parameter for weather feedstocks can easily inject in reactor or not. As temperature is increased, the flow properties of PBFS and CTBFS are improved as shown in Fig.1. It means these two feedstocks easily atomize in furnace reactor. The rheometer, Moving Die Rheometer C (Make Alpha Technologies Hudson Ohio, USA), a convenient instrument was used to evaluate the effects of carbon black rubber interactions on rate of cure, was employed for the purpose of characterizing critical parameters

related to the vulcanization process. The rheological parameters are provided in Table 2
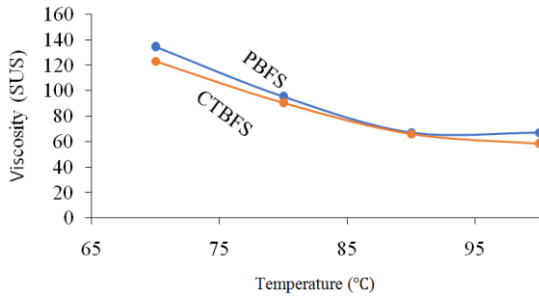

Fig.1 Viscosity in SUS of different feedstocks at various temperature
*SUS: Saybolt Universal Seconds

Table 2: Rheometric data of different CBs

Parameters	PBFS-CB	CTBFS-CB
ML(lbf-in)	3.06	3.43
MH (lbf-in)	15.88	16.52
TC90 (mm: mm)	20.70	19.33
TS2 (mm: mm)	2.71	2.51
MH-ML (ΔM) (lbf-in)	12.82	13.09

*ML: Minimum torque is a measure of the extent of mastication; MH: Maximum torque is an indication of the cross-linking density of the fully vulcanized rubber: TC90: the time required for the torque to reach 90% of the maximum: TS2: the time from start of the test to the moment when the torque value increases for 2 lbf-in above the ML value; MH-ML(ΔM): range of torque change

2.2 Preparation Of Different Cbs From Different Sources
The Petroleum-based feedstock was preheated at temperature of 210 °C and it injects into furnace reactor through a fine orifice nozzle to atomizer PBFS and in simultaneously of preheated atmospheric air blowing at the temperature 750 °C to facilitate the combustion of PBFS. The ample amount of heat is being liberated due to exothermic nature of reaction and raising the furnace reactor inside temperature up to 1800 °C. At this high temperature, the thermal cracking of hydrocarbons in PBFS occurs and produces carbon black along with high calorific value flue gases (CB-HCVFG). The produced CB-HCVFG used as a source of heat, is recirculating in counter flow direction of PBFS and atmospheric air to increase the initial temperature of inlet PBFS and atmospheric air through heat exchange equipment's, known as Oil pre heater (OPH) &Air pre heater (APH) respectively. In this continuous process, thermal cracking of PBFS in furnace reactor is slowing down by sprinkling of water at the end of furnace reactor to obstruct complete combustion of PBFS and to facilitate of carbon black generation. After recovery of heat from

CB-HCVFG via preheating the inlet PBFS and atmospheric air, the CB-HCVFG passes through filtration process to separate the carbon black (CB) from HCVFG (Fig.1). The obtained carbon black is characterizing with help of sophisticated further processes, i.e., binder addition, palletization, drying etc. The sameprocedures were repeated with CTBFS to produce another type of carbon black.

2.2.1 Preparation of Rubber with Different Cbs
The obtained CBs samples were dried at 125 °C for 1 hour and cooled till ambient temperature was reached. Until ready to mix, stored the CBs in an airtight, moisture-proof container. Natural rubber (ISNR 3 CV), zinc oxide (ZnO), stearic acid, carbon black, and MBTS were fed into an open mill machine after heating at 70 °C and set the mill opening at 1.4 mm to start the mixing in sequence of ASTM D 3192. The obtained rubber sheet is conditioned at 23 °C for one hours before bringing the mould to the curing temperature in closed press. Placed 70 gm of rubber compound in the mould cavity and vulcanised for 30 minutes at 145 °C and 135 MPa pressure for the fabrication of rubber sheets (Farida et al., 2019). The raw material composition in parts per 100 parts of rubber (PHR) has been carried out as per ASTM D 3192 (Table 3).

Table 3 Preparation of rubber compound with different CBs

Ingredients for rubber sheet	PBFS (PHR)	CTBFS (PHR)
Natural Rubber (ISNR 3 CV)	100.0	100.0
Carbon Black	50.0	50.0
ZnO	5.0	5.0
Stearic Acid	3.0	3.0
MBTS	0.60	0.60
Sulphur	2.5	2.5

*PHR: Parts per 100 parts of Rubber(weight of ingredients are in gram w.r.t. 100 gram of rubber)

2.3 Characterization of CB samples
2.3.1 Morphology of CB samples
The collected CBs were taped to the sample holder with carbon tape. A gold sputter coater was used to coat the CBs for conductivity. The samples were placed in FESEM (Make: TESCAN, Model: MIRA 3).Examined the morphology of various CBs at 20 kV.

2.3.2 Fourier Transform Infrared spectroscopy (FTIR)
The CBs were mixed with KBr. Prepared CBs sample pellet using pelletizer. The prepared pellet was placed in FTIR (Make: PerkinElmer, Model: spectrum 2). Operated FTIR from 450 to 4000 cm-1and examined functional groups contained in various CBs.

2.3.3 X-ray diffraction of CB samples
The CBs were powdered, and the powdered samples were poured onto a glass slide. After flattening the powdered samples with the help of spatula, the glass

slide was placed in X-ray diffraction (Make: Rigaku Model: DMAX2200). The XRD operated at a rate of 3 theta/min within the functioning range 2Ө: 0-70. (Srinivasaraonaik et al., (2021). Investigated the mineralogical properties of CBs samples with existing d-values in the system. Figure 2 gives preparation of carbon black flow diagram.
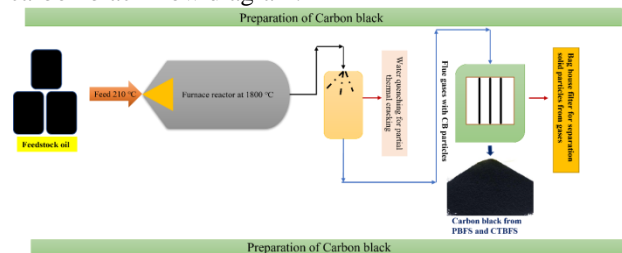

Fig.2 Flow diagram for preparation of various carbon black

2.3.4 Particle size distribution of CB samples
The CB samples were dispersed in Isopropanol as solvent. The dispersed samples were taken into Particle Size Analyzer (Make: Horiba, Model: LA-950). The particle size distribution curve of various CBs was observed at refractive index of 0.5.

2.3.5 BET analysis of CB samples
BET method was used as per the ASTM D6556. The surface area is determined by N2adsorption and desorption at 77K and partial pressure (Lippens and Boer, 1965). The BET Equation is used to calculate the filler's surface area:

$$S_{BET} = V_m \times N \times a_m \times 10^{-18}$$

Here, V_m is Monolayer adsorbed volume; N is Avogadro constant $(6.02 \times 10^{23}$ 1/mol), a_m is 0.16 i.e., N2 molecular surface area.

2.3.6Colloidal Properties of different CB samples
Oil absorption number, Iodine adsorption number, and compressed oil absorption number were determined according to ASTM D 2414, ASTM D 1510, and ASTM D3493.

2.3.7 Proximate analysis of CBs
Proximate analysis is widely used to determine moisture, volatile matter (VM), fixed carbon (FC) and ash content of CBs. The proximate analysis was done as per ASTM D 162-84 method

2.3.8 Determination of tensile strength
Conditioned the cure rubber sheet for an hour at room temperature and cut the dumbbell from it. Determined the thickness of the thin portion of dumbbell and marked it. Set the tensile tester machine parameter for Test speed and Gauge length at 500 mm/min and 25 mm respectively. The tensile strength and modulus 300 percent of CBs in rubber were evaluated using a Tensile Testing Machine -Zwick 1435 (ZwickRoellPvt. Limited Germany) in accordance with ASTM D412.

2.3.9 Dynamic properties of CB samples in rubber
ASTM D5963 and ASTM D 623 methods were used to investigate the dynamic parameters of CB samples into the rubber, i.e., abrasion loss and heat buildup (HBU). The rubber sheet was cured at 145 °C for 30 mins. The abrasion loss of rubber sheets was measured at vertical force load 10N. As well as heat buildup of rubber sheet was measured for 30 minutes at set temperature 100 ℃ conditioned for 30 minutes.

2.3.10 Rheological properties of CB samples in rubber
Moving Die Rheometer C (Make: Alpha Technologies Hudson Ohio, USA) used for determination of rheological properties of CBs in rubber.It is an expedient instrument was used to evaluate the effects of carbon black rubber interactions on rate of cure of rubber. It was employed for characterizing critical parameters of CBs in rubber which is related to the vulcanization process.

3. RESULTS AND DISCUSSIONS
3.1 Morphology of CBs
The morphology of various samples PBFS-CB and CTBFS-CB are from PBFS and CTBFS shown in Fig.3 The majority of CB particles form a cluster aggregate, while aninsignificant percentage of CBs aggregate closer together to form a bigger CB block (Fig.3 (a) and (b).
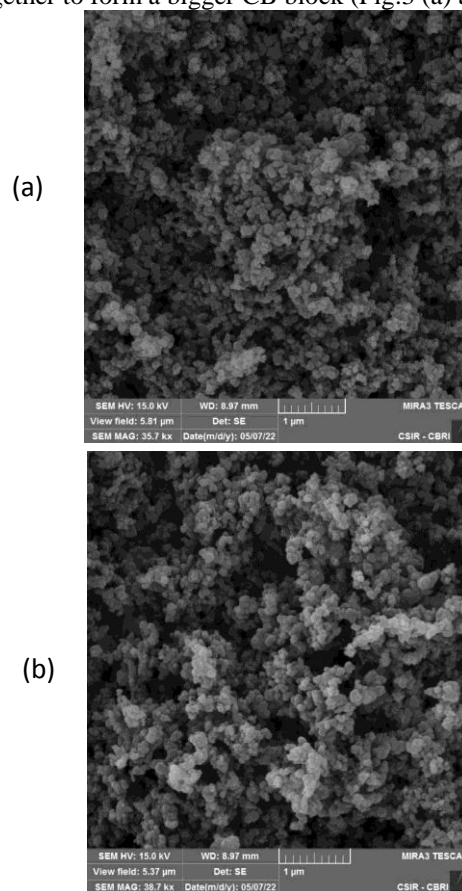

Fig.3 Morphology of different carbon black (a) PBFS-CB (b) CTBFS-CB

These CB micro particles, on the other hand, are approximately ring-shaped and are practically linearly connected. The aggregate's total size is slightly lower.It has a more developed spatial structure and is improving, implying that the reinforcing performance will improve.

3.2 X-ray diffraction analysis of CBs
Fig.4 shows the XRD analysis of various CBs generated at 1800 °C. Both diffractograms exhibit two broad peaks, showing that the two samples are amorphous carbon materials with limited crystallinity areas Fig. 4(a) and (b). The planes of graphitic structures are represented by the peaks at 25.9° in both samples, and the graphitic structure planes are represented by the second intensity peak at about 44.7° in the samples. Both of these peaks confirm that the CBs were successfully transformed into

graphitic nanostructures at high temperatures. Furthermore, there is no significant a prominent peak observed. Due to impurities, the XRD patterns indicate that the purity of the CBs produced in this experiment is higher, which is consistent with the results given in Fig. 4 (a) and (b).
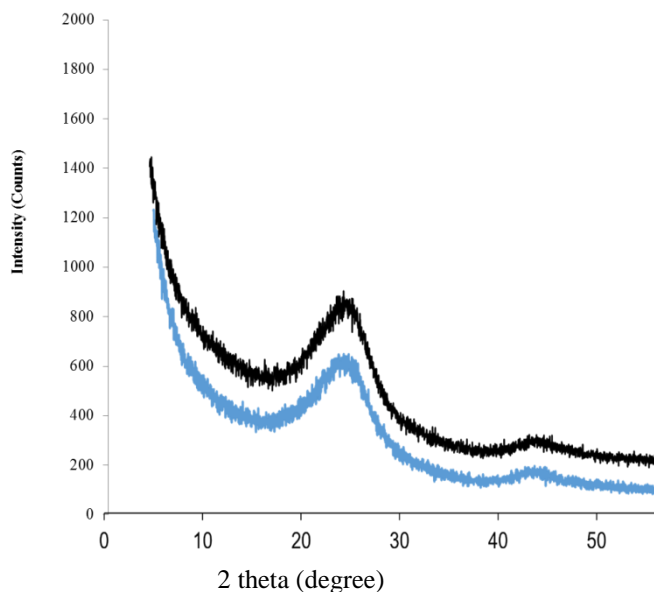

Fig.4 XRD analysis of different carbon black samples (a) PBFS-CB (b) CTBFS-CB

3.3 FTIR analysis of CBs

FTIR analysis of various CBs functional groups are shown in Fig. 5. Nonbonded hydrogen group, OH stretching, Methane (=CH-) C–H stretching, and Methylene (=CH2) C–H stretching were identified in the spectra of PBFS-CB peaks 3595 cm-1 and 2875 cm-1, respectively. Alkenyl C=C stretching and Skeletal C–C stretching have absorption maxima of 2085-1489 cm-1. Stretching vibrations peaks at 965-854 cm-1 and 694 cm-1 are observed corresponding to trans C–H out-of-plane bend and cis C–H out-of-plane bend in Fig. 5(a). The FTIR analysis of CB functional groups of CTBFS-CB has shown in Fig.5 (b). Nonbonded hydrogen group, OH stretching, Methane (=CH-) C–H stretching, and Methylene (=CH2) C–H stretching were identified in the spectra of CTBFS-CB peaks 3597 cm-1 and 2870 cm-1, respectively. The absorption maxima for Alkenyl C=C stretching and Skeletal C–C stretching are 2089-1493 cm-1 and 2089-1493 cm-1, respectively. Stretching vibrations of the functional groups such as trans C–H out-of-plane bend and cis C–H out-of-plane bend are seen at 962-859 cm-1 and 697 cm-1, respectively (Fig. 5(b)).

Wavenumber (cm-1)
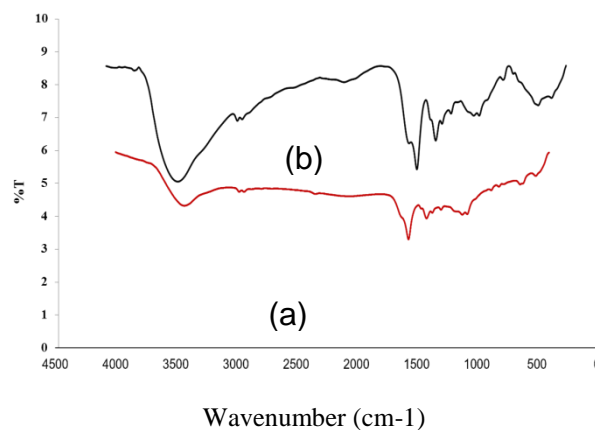
Fig.5 FTIR analysis of different carbon black samples (a) PBFS-CB (b) CTBFS-CB

The PBFS-CBand CTBFS-CB products obtained from the furnacereactor at 1800 °C revealed there is no significant differences observed. In both cases, changes in carbon percent had little effect on the spectra peaks, as seen in Table 4 (Wibawa et al., 2020).

Table 4 Proximate Analysis of different carbon black samples

Parameters Content (%)	Test Method	PBFS-CB	CTBFS-CB
Moisture	ASTM D 1509	1.6	1.5
Ash	ASTM D 1506	0.18	0.26
Volatile	ASTM D 1620	4.6	4.7
Fixed carbon	ASTM D 7679	93.02	91.2

*PBFS-CB: Petroleum based feedstock carbon black; CTBFS-CB: Coal tar-based feedstock carbon black
Note – ASTM D 1620 "Method of test for volatile content of carbon black" was discarded in 1972

3.4 Particle size distribution of CBs

The particle size analysis of the various CBs is displayed in PSA with a poly-dispersion index of 0.5, and their pattern is shown in Fig. 6. The statistical computation of the created curve pattern of the particles size distribution of the CBs material is shown in this figure. A mean diameter of 1305 nm (1.3 µm) (PBFS-CB)) and 1360 nm (1.36 µm) (CTBFS-CB)) with a standard deviation (SD) of 1245 nm (1.24 µm) (PBFS-CB) and 1246 nm (1.24 µm) (CTBFS-CB) can be noticed, with a standard deviation (SD) of 1245 nm (1.24 µm) (CTBFS-CB). Various CBs modes are 548 nm (0.54 µm) and 624 nm (0.62 µm), which correspond to PBFS-CB and CTBFS-CB, respectively. CB particle populations in PBFS-CB range from 907 nm (0.9 µm) to 1305 nm, while CB particle sizes in CTBFS-CB range from 966 nm (0.9 µm) to 1361 nm (1.36 µm) (Fig.6). The poly dispersion (PI) index of CBs is 0.5, which explains the undersize proportion. However, the smaller the particles, the better the surface area characteristics, and the produced CBs were then studied further.
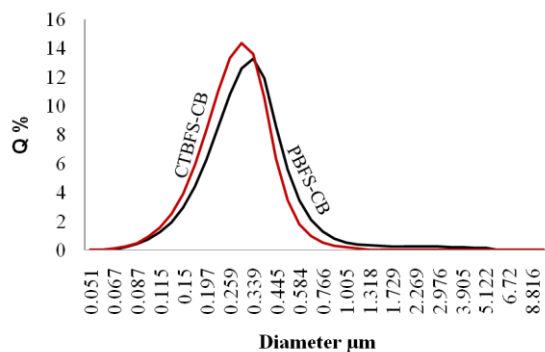
Fig. 6 Particle size distribution of different samples (a) PBFS-CB (b) CTBFS-CB

3.5 Surface area of various CBs

BET surface area of CBs manufactured at 1800°C utilizing the same procedures from various sources, namely PBFS and CTBFS. The surface area of several CBs was determined using BET. Because it indicates the extent of the interface, such as the availability of the surface for crosslinking between rubber chains and carbon black, surface area is an important morphological parameter for carbon black reinforcing capability. The surface area result could help determine not only how much of the area that rubber can absorb into the carbon black, but also how much of the area that rubber can absorb into the carbon black. CBs produced from PBFS and CTBFS had surface areas of 112.6 m2/g and 111.06 m2/g, respectively(Fig.7).PBFS-CB and CTBFS-CB have not changed much as a result of nuclei at high temperatures enlarging due to the adhesion of intermediate products. Due to uneven adherence in both cases, additional micro-pores generated throughout the adhesion process, resulting in a nearly constant BET surface area. The BET surface area constant of the thermal degradation process at 1800 °C was likewise consistent with XRD analyses (Fig.4).
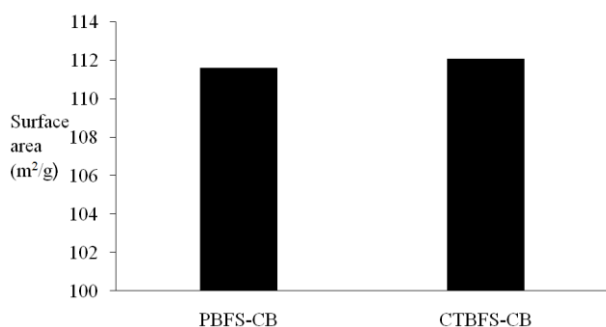

Fig.7 Surface area of various carbon black samples

3.6 Proximate analysis of CBs

The proximate analysis of PBFS-CB and CTBFS-CB are given in Table 4. The mass fraction of moisture content and volatile matter are same observed in both samples. The ash and fixed carbon are 0.18 wt.% and 93.02 wt.%, 0.26 wt.% and 91.2 wt.% corresponding to PBFS-CB and CTBFS-CB respectively. The ash content and fixed carbon differed due to slightly change in volatile matter (Table 4.).

3.7 Colloidal properties of various CBs incorporated the natural rubber

The colloidal characteristics of different CBs were determined using ASTM D 2414, ASTM D 1510, and ASTM D 3493, which stand for Oil absorption number,

Iodine adsorption number, and compressed oil absorption number, respectively. Table 5 shows their respective values. The results of the iodine adsorption method have been confirmed to be favourably linked with the BET method. CB is first mixedin an iodine solution. The excessive amount of iodine is titrated using a normal sodium thiosulfate solution. The carbon black surface area determines the eventual adsorption number (AN). The iodine adsorption values of PBFS-CBand CTBFS-CB are 121.5 mg/g and 120.8 mg/g, respectively. Moisture absorbed, Pores, volatiles, and sometimes ageing can affect the surface area of the filler (Mark et al., 2013). Furthermore, the DBP absorption of these CBs is 114.2 and 113.6 cc/100 gm for PBFS-CBand CTBFS-CB, respectively. These are high values (Table 5), showing that the quantity of assemblages formed by these CB nanoparticles is bigger and that a large number of void spaces are developed, implying that the aggregate's spatial arrangement is better overall.

Table 5 Colloidal Properties of different carbon black samples

Parameters	Test Method	PBFS-CB	CTBFS-CB
Fines (%)	ASTM D 1508	4.6	5.2
Sieve residue (#35) (%)	ASTM D 1514	0.0005	0.0001
Pellet hardness (25%) (Gf)	ASTM D 3493	24.3	22.4
CDBP (CC/100gm)	ASTM D5230	92.4	91.5
Sulphur Content (%)	ASTM D 7679	0.97	0.54
Pour density (kg/m^3)	ASTM D 1513	364	358

3.8 Mechanical properties of Various CBs incorporated the natural rubber

The rubber sheets were prepared as per standard ASTM D 3192 composition. ASTM D412 was used to determine the tensile strength and modulus 300 percent of various CBs. PBFS-CB and CTBFS-CB have tensile strengths of 18.4 MPa and 18.0 MPa, respectively (Fig.8). The 300 % modulus of various CBs such PBFS-CB and CTBFS-CB is 487 MPa and 484 MPa, respectively (Fig.8). Due to the nearly identical BET surface area (Fig.7) and particle size distribution (Fig. 6)in PBFS-CB and CTBFS-CB, the tensile strength and modulus 300 % (Fig.9) are not different. However, minimal difference is observed due to the change in compactness during the preparation process.
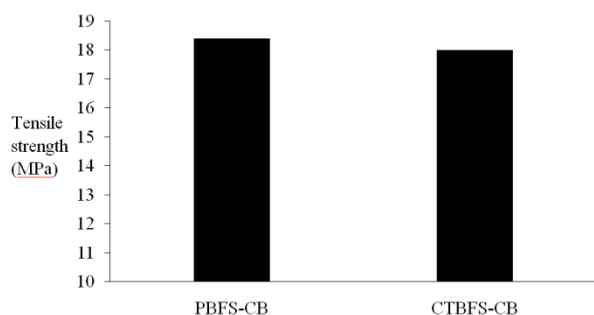
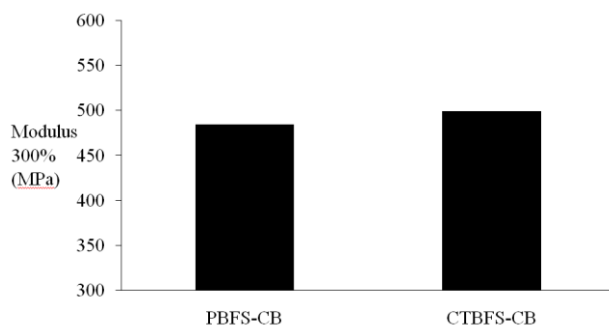Fig.8 Tensile strength of various carbon black samples mixed in rubber

Fig.9 Modulus of various carbon black samples mixed into natural rubber

3.9 Dynamic properties of various CBs incorporated the natural rubber

The dynamic properties of various CBs such as PBFS-CB and CTBFS-CB i.e., abrasion loss and heat build-up (HBU) have been determined in accordance with ASTM D5963 and ASTM D623.PBFS-CB and CTBFS-CB have the abrasion loss of 134 mm^3 and 131mm^3, respectively (Fig.10).The HBU of various CBs such as PBFS-CB and CTBFS-CB is 24 °C and 26 °C, respectively.The abrasion loss and heat build-up (HBU) are not differed due to the approximately identical tensile strength (Fig.8) and Modulus 300%(Fig. 9) in CB samples.
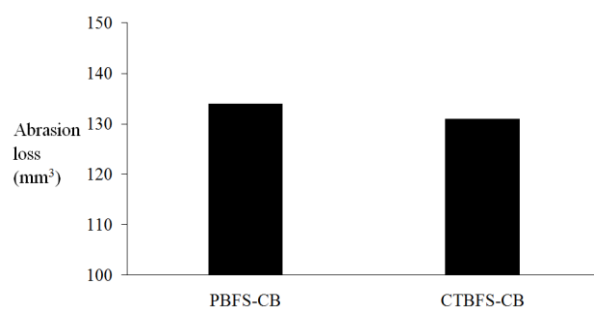

Fig.10 Abrasion loss of various carbon black samples mixed into natural rubber

3.10 Rheological properties of various CBs incorporated the natural rubber

The rheological properties of various CBs,incorporated in natural rubber, such as minimum torque, maximum torque and change in cure rate were examined at 145 °C.The obtained results are illustrated in Table 2. The CTBFS-CB shows slightly fast cure nature than PTBFS-CB due to PBFS has higher percentage of sulphur content and which retards the vulcanization.

4. CONCLUSION

The Physio-chemical Properties of CBs such as PBFS-CB and CTBFS-CB Produced from two different feedstocks, PBFS and CTBFS were successfully examined in this work. Both the CBs chemical and mechanical qualities were tested. The experimental findings demonstrated that good co-relation in aggregate particle size distribution of samples produced with CTBFS and PBFS as feedstock. There are no significant changes observed in surface area of the various CBs. The particle size of different CBs observed 1.30 µm and 1.36 µm. The tensile strength and Modulus 300% are almost same values observed in CBs. The abrasion loss and heat build-up (HBU) are not differed due to the nearly identical tensile strength and Modulus 300% in PBFS-CB and CTBFS-CB.

The eventualAN is relative to surface area of CB. The PBFS-CB and CTBFS-CB have iodine adsorption values of 121.5 mg/g and 120.8 mg/g, respectively whereasthe DBP absorption of these CBs is 114.6 and 113.2 cc/100 gm, respectively. The obtained results are comparable for PBFS-CB and CTBFS-CB. The results of the investigation reveal that the influence of different feedstock types can be mitigated technically by enhancing the control of the Carbon black production process. It also proves that technological advancements in the carbon black business may give consistent results regardless of the input material.

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