

Electronic supplementary information

**for**

**Activated Charcoal mediated purification of Yellow Sodium Sulphate: A green process to utilize a hazardous by-product of leather chemical industry.**

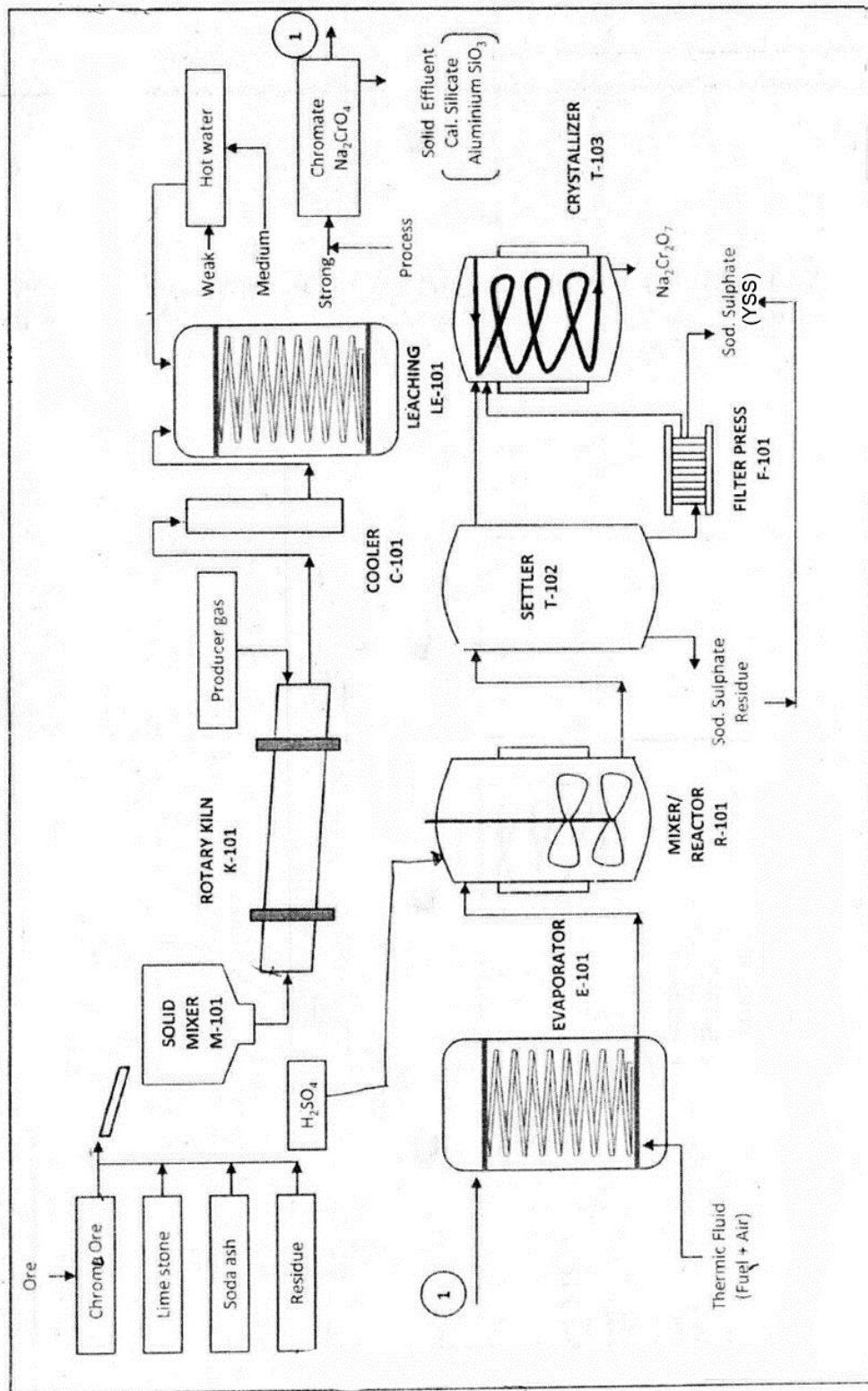
Sandipan Chatterjee\*, Rajarshi De<sup>†</sup>, Arka Gupta<sup>†</sup>

<sup>†</sup> *Authors contributed equally in this work*

<sup>1</sup>*Council of Scientific and Industrial Research (CSIR)-Central Leather Research Institute (CLRI),  
R.C.E.D.-Kolkata, 3/1C, Matheswartala Road, Kolkata-700046, India.*

*Tel: 91 -33- 23292381; Fax: 91-33-23296046;*

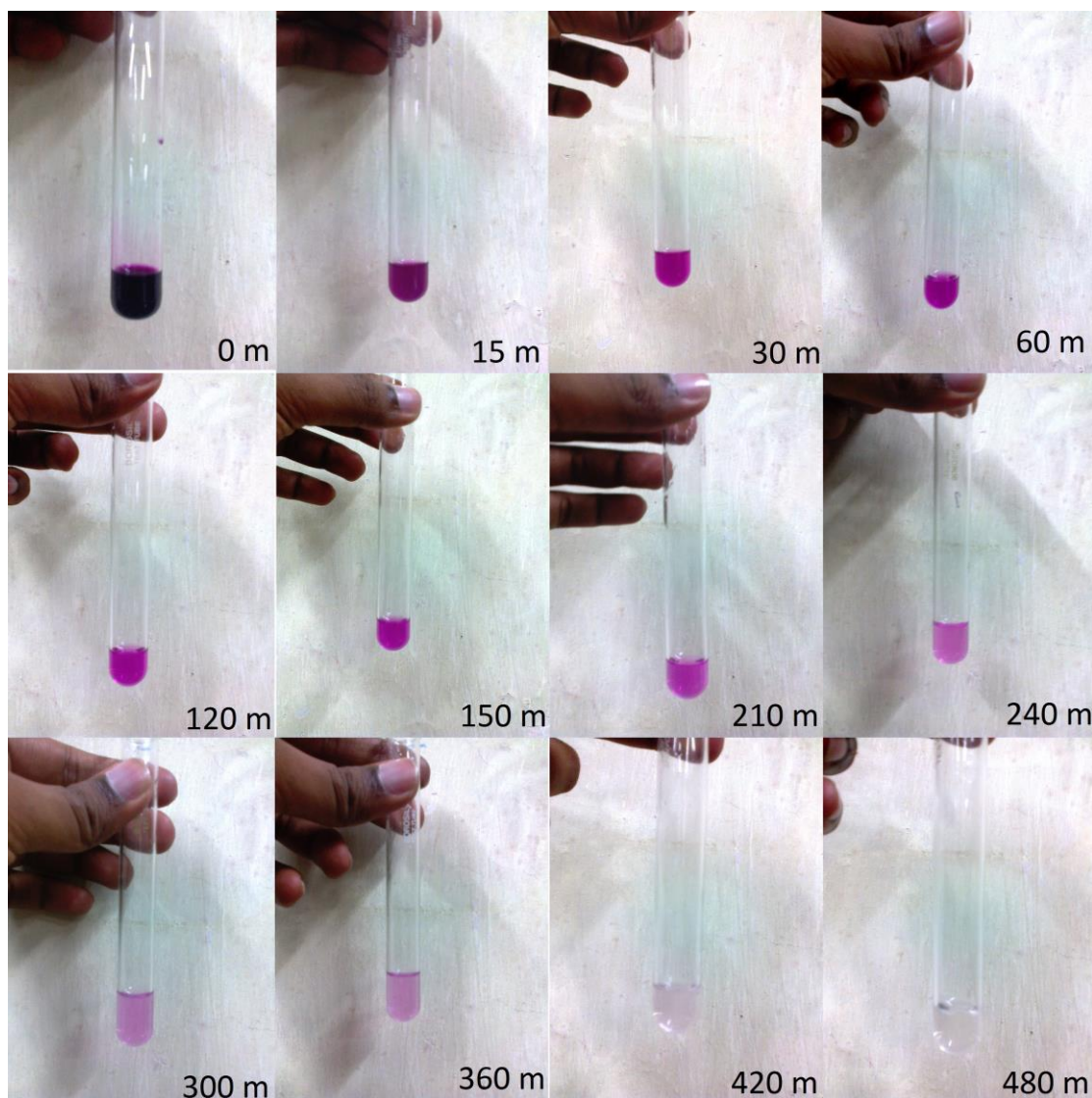
Email: [sandipan@clri.res.in](mailto:sandipan@clri.res.in) , [Sandipan.clri@gmail.com](mailto:Sandipan.clri@gmail.com)



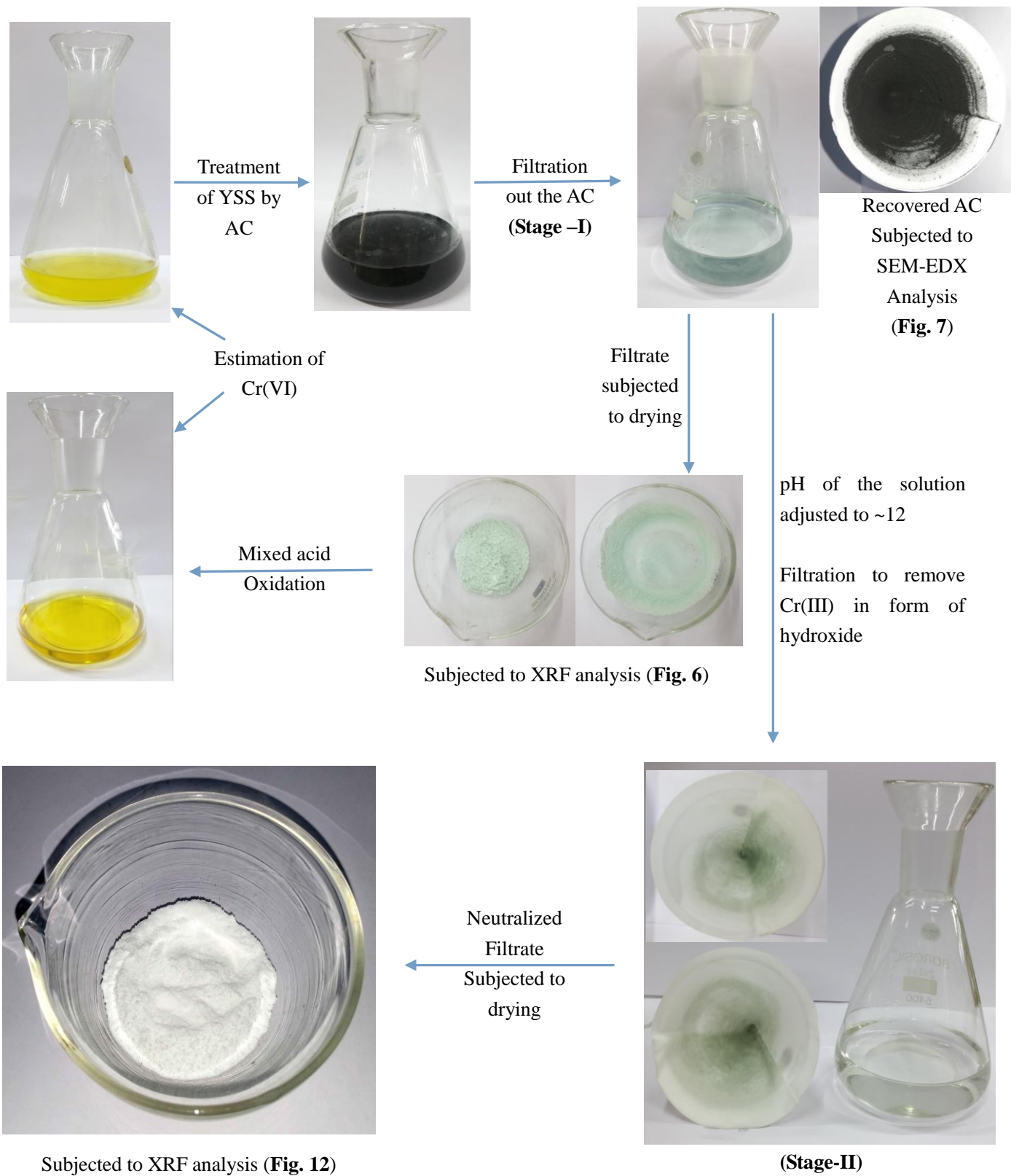
**Fig. 1.** Industrial setup of BCS manufacturing process in leather chemical industries.



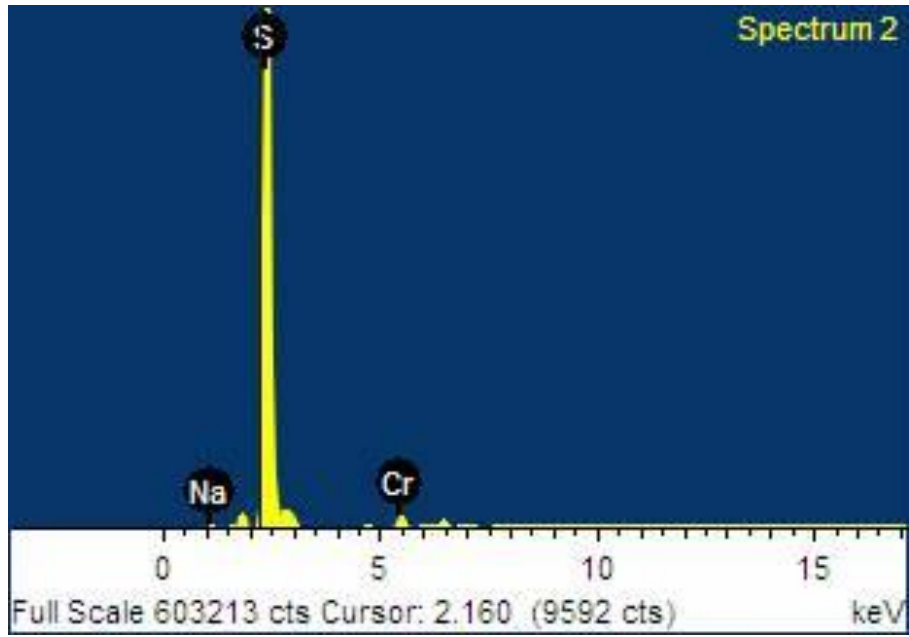
**Fig. 2.** Accumulated YSS in different BCS production units.



**Fig. 3.** Removal of Cr(VI) from YSS solution with time during the AC treatment.

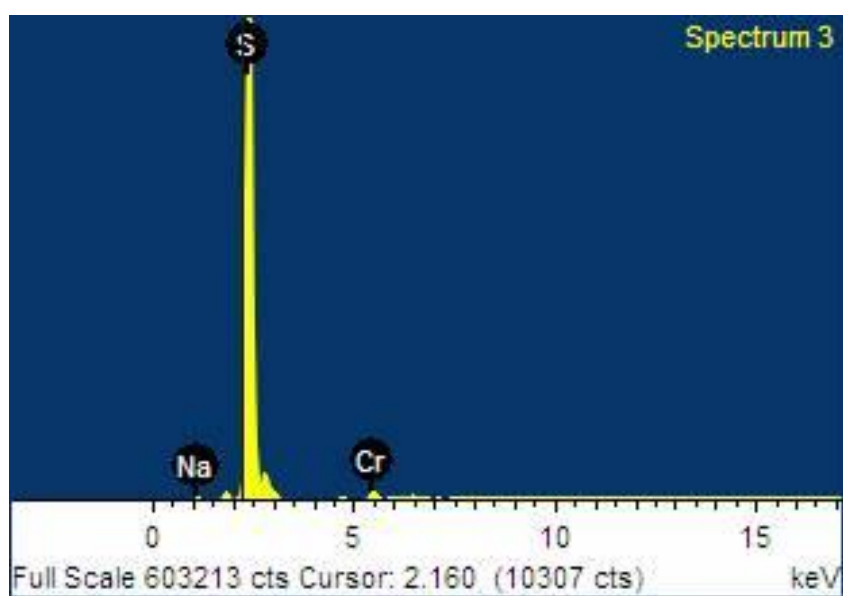


**Fig. 4.** Stage-wise purification of YSS using AC.



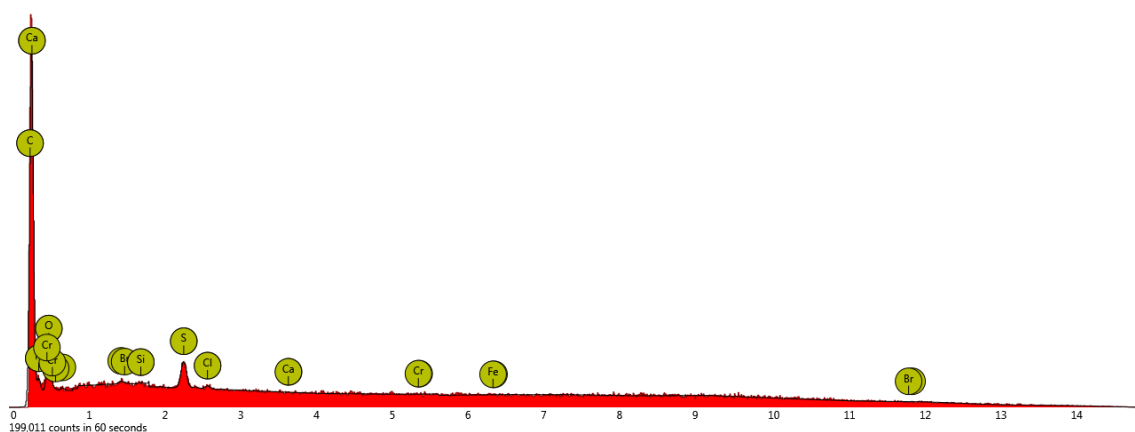
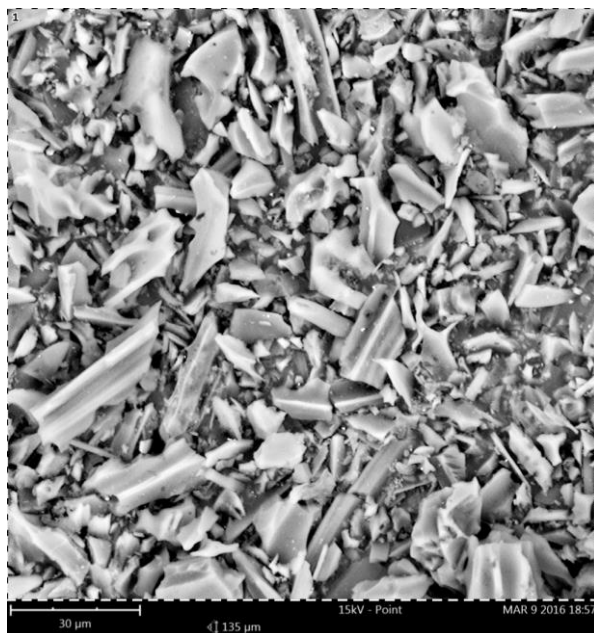
Elem.	Line	Mass[%]	3sigma	Atomic[%]	Intensity[cps/mA]
11 Na	K	39.28	0.72	47.53	48.71
16 S	K	60.05	0.71	52.11	16076.98
24 Cr	K	0.67	0.01	0.36	371.56

**Fig. 5.** XRF analysis report of YSS before treatment.



Elem.	Line	Mass[%]	3sigma	Atomic[%]	Intensity[cts/mA]
11 Na	K	36.16	0.76	44.2	45.11
16 S	K	63.34	0.75	55.53	17548.88
24 Cr	K	0.59	0.01	0.27	275.68

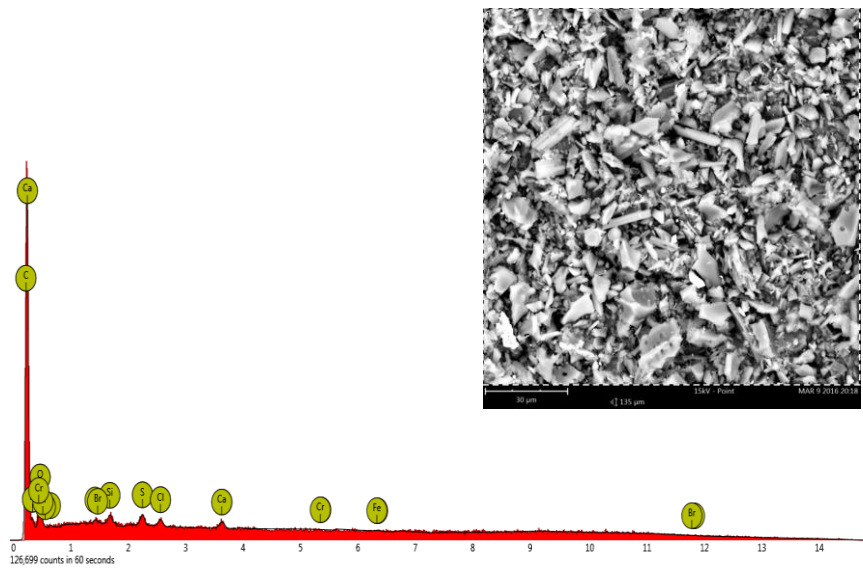
**Fig. 6.** XRF analysis report of green solid obtained by the evaporation of greenish liquid after stage –I treatment.



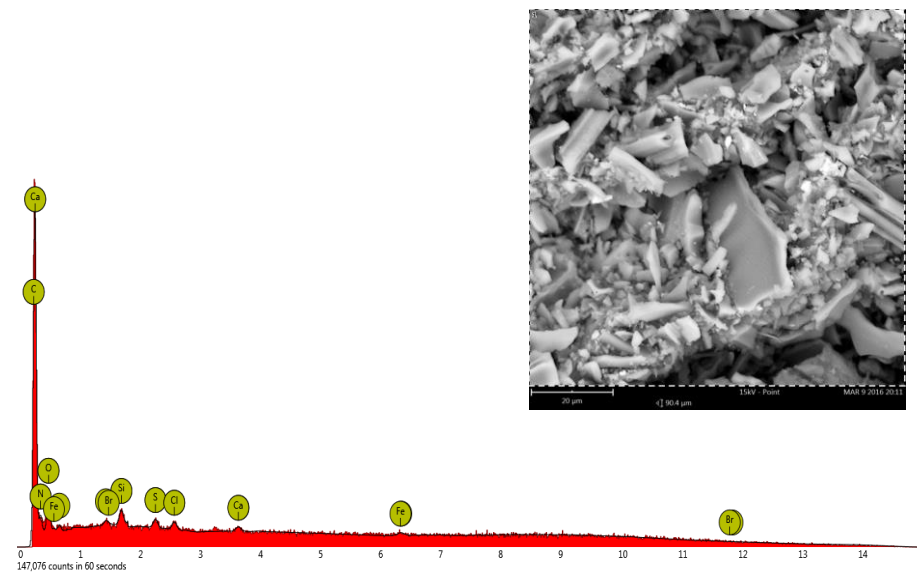
Element Number	Element Symbol	Element Name	Weight Concentration	Error
6	C	Carbon	31.4	0.9
8	O	Oxygen	48.6	0.1
16	S	Sulfur	6.5	0.1
7	N	Nitrogen	11.4	1.1
17	Cl	Chlorine	0.9	0.9
35	Br	Bromine	1.0	0.9
14	Si	Silicon	2.7	0.2
24	Cr	Chromium	0.0	0.6
20	Ca	Calcium	1.0	1.2

**Fig. 7.** SEM-EDX analysis (area scan) report of recovered charcoal after YSS treatment.



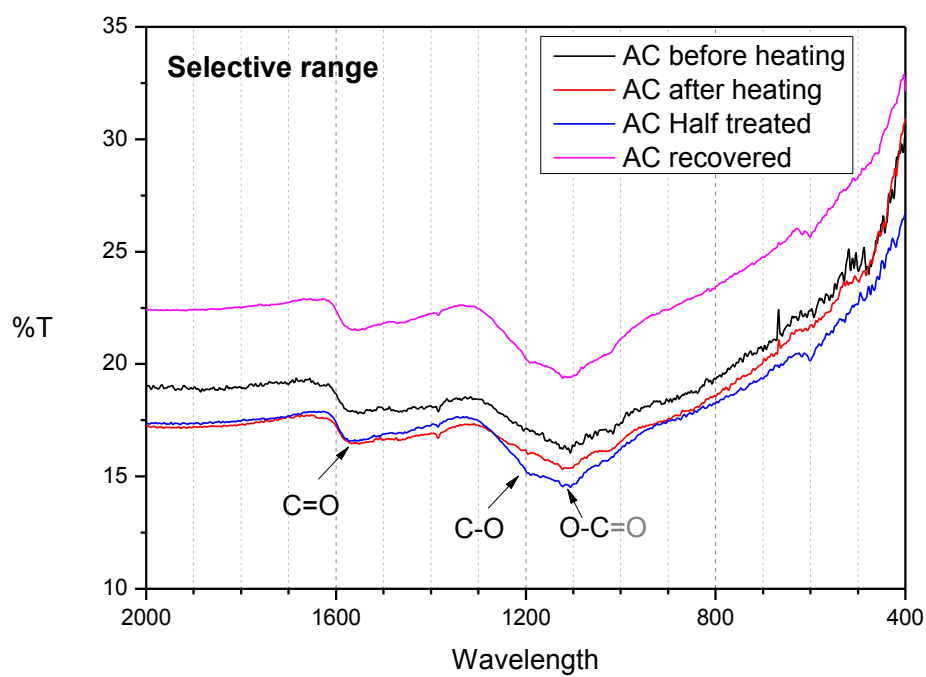
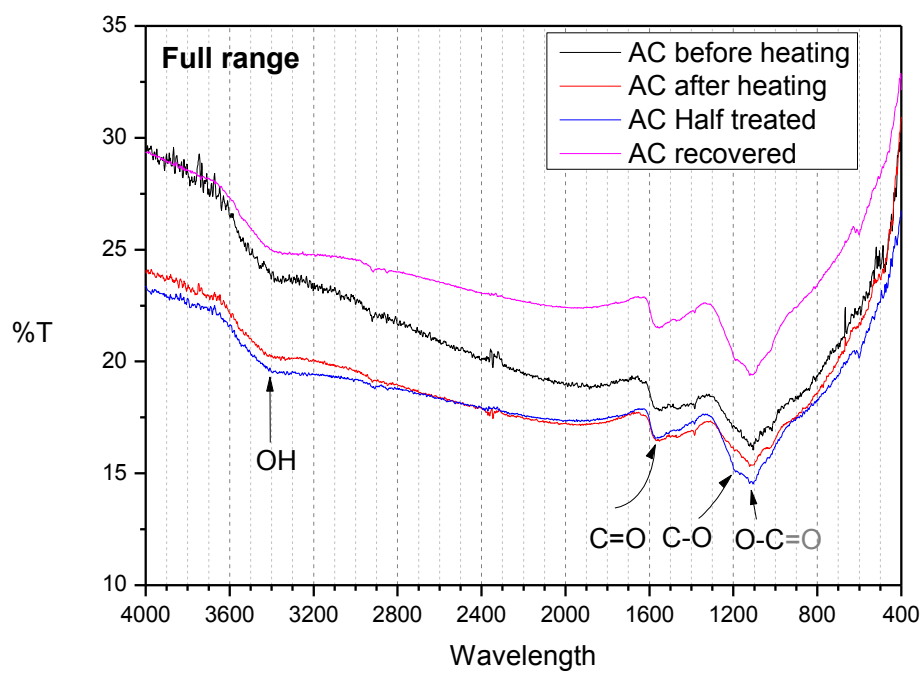


Element Number	Element Symbol	Element Name	Weight Concentration	Error
6	C	Carbon	32.8	0.8
8	O	Oxygen	45.1	0.2
16	S	Sulfur	2.9	1.0
20	Ca	Calcium	2.8	0.6
14	Si	Silicon	1.7	0.8
17	Cl	Chlorine	2.2	0.5
7	N	Nitrogen	10.2	1.2
35	Br	Bromine	1.6	0.6

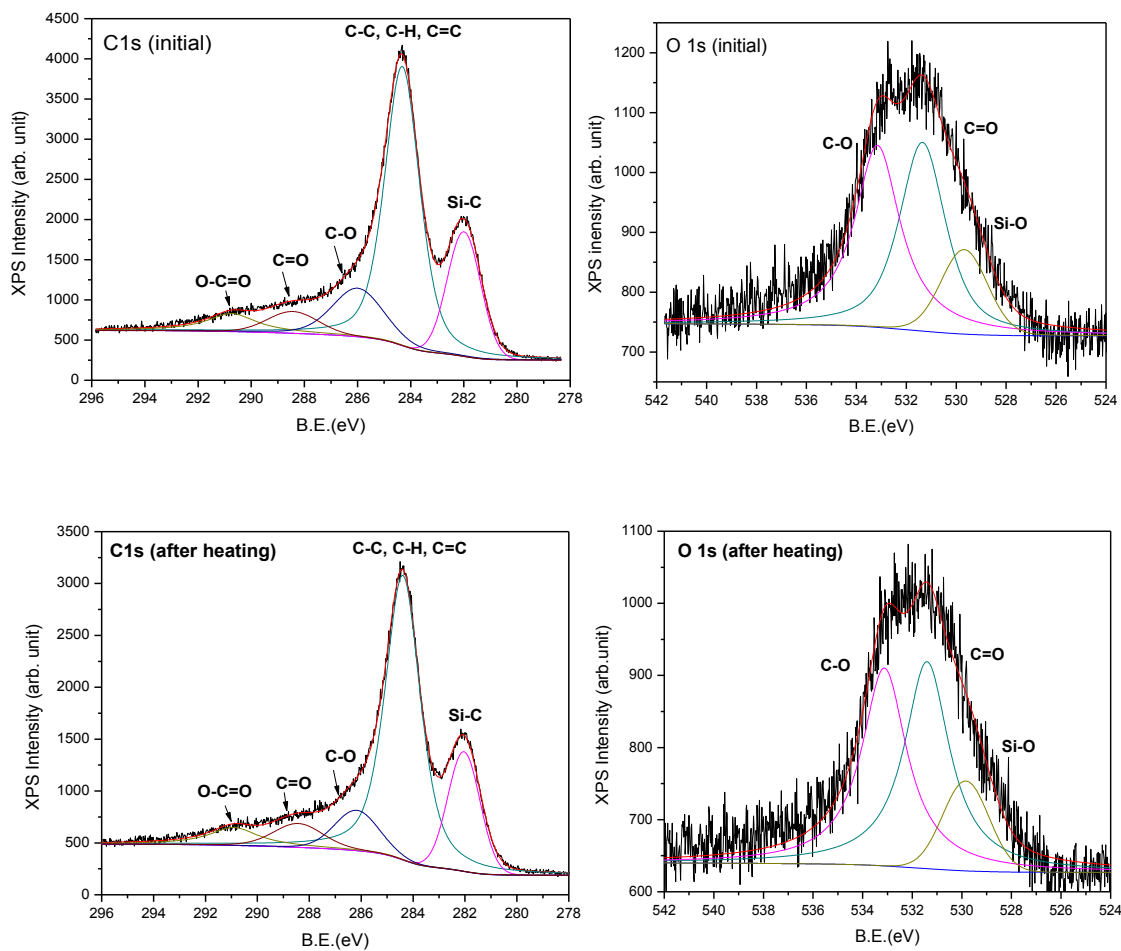


Element Number	Element Symbol	Element Name	Weight Concentration	Error
6	C	Carbon	28.0	0.8
8	O	Oxygen	46.3	0.0
14	Si	Silicon	2.4	0.3
7	N	Nitrogen	12.1	3.5
16	S	Sulfur	2.0	0.9
17	Cl	Chlorine	2.3	0.8
20	Ca	Calcium	1.7	1.0
35	Br	Bromine	1.7	0.3

**Fig. 8.** SEM-EDX analysis (area scan) report of activated charcoal procured from Merck (left) and after heating at 100 °C prior to use (right).

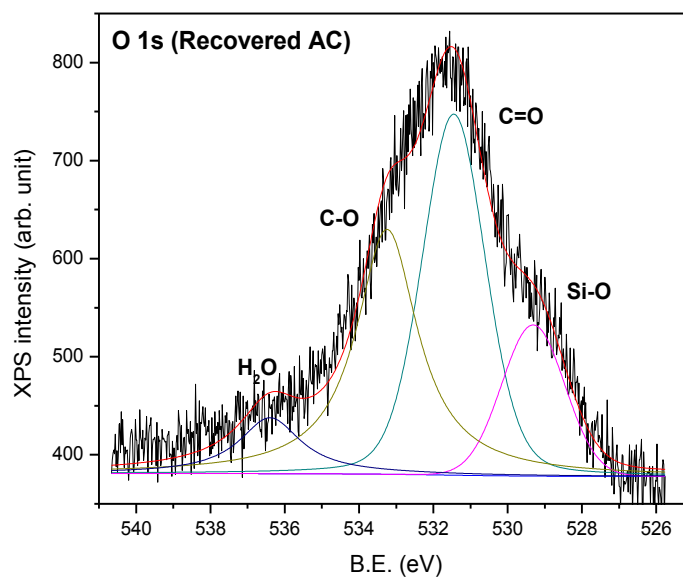


**Fig. 9.** FT-IR analysis of activated charcoal at different stages of experimentation.



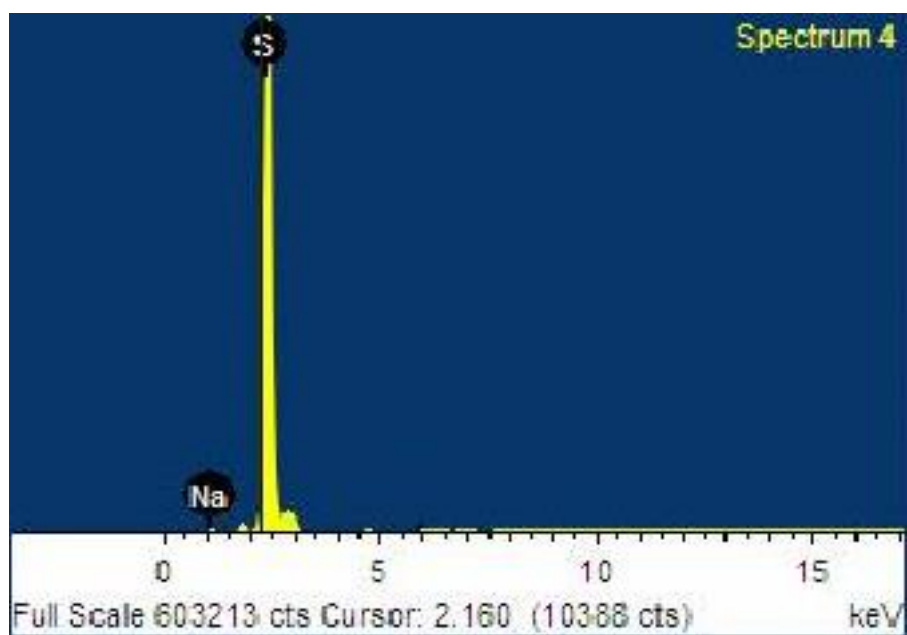
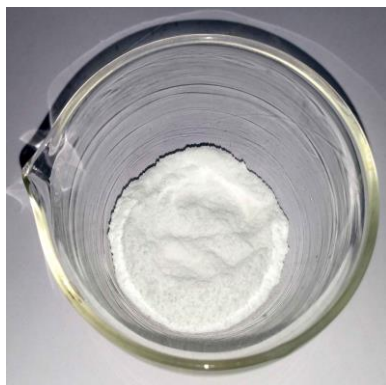
**Fig.10.** C1s and O1s XPS spectra of AC initial (top) and after heating at 100 °C (bottom).

NB: Distinct peak at 282 eV of core C1s spectra and 529.3 eV of core O1s spectra are indicating the contamination of silicon impurities in the AC sample. Occurrence of silicon in AC sample has already been indicated in SEM-EDX spectra. Procured AC sample was prepared from plant sources; where occurrence of oxygenated silicon compounds is a well-known fact. During high temperature production of AC, some part of it may be transformed into carbonated silicon compound; hence both the Si-O and Si-C groups are indicated in the XPS spectra of present AC sample.



**Fig.11.** O1s XPS spectra of recovered AC

NB: Tiny peak centered at 536.4 eV of in O1s spectra of recovered AC indicating the presence of minute water/chemisorb oxygen in the material.



Elem.	Line	Mass[%]	3sigma	Atomic[%]	Intensity[cps/mA]
11 Na	K	40	0.68	48.18	55.19
16 S	K	59.98	0.68	51.81	17447.05

**Fig. 12.** XRF analysis report of solid (purified  $\text{Na}_2\text{SO}_4$ ) obtained by the evaporation of liquid after stage –II treatment.

## **Experimental procedure of material characterization.**

### **XRF analysis**

Mineral samples were analyzed by Horiba XGT 7200 micro ED-XRF system. The X-rays was generated using 50 Kv/1mA Rh based X-ray source. Measurements were carried out in vacuum and data were recorded using Peltier cool high purity Si(Li) semiconductor detectors. Resulted data were quantitative analysis by standard less fundamental parameters method (FPM)

### **XPS spectra**

XPS spectra of the carbon samples were recorded by Omicron energy analyzer equipped with monochromatic X-ray sources Al  $k\alpha$  ( $E = 1486.6$  eV) and Mg  $k\alpha$  ( $E = 1253.6$  eV). Deconvolution of the merging peak were done with 4.1 version of XPSpeak software.

### **SEM EDX**

SEM-EDX analysis of the samples was done using Phenom-ProX desktop SEM equipped with EDS unit.

### **FT-IR data acquisition**

FTIR spectra of the samples were recorded using Perkin Elmer Spectrum-100 instrument. Average of total 40 no of scan were taken for each samples.