JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue

JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)

An International Scholarly Open Access, Peer-reviewed, Refereed Journal

COMPARATIVE STUDY OF DIFFERENTIAL SCANNING CALORIMETRY (DSC) ANALYSIS OF HDPE AND HDPE-WALNUT SHELL COMPOSITES.

[1]Suprit Malagi, [2]Dr. S.V.Gorabal,

[1]Assistant Professor, [2]Principal [3] Professor

[1]Mechanical Department S G Balekundri Institute of technology, Belagavi, India

[2] Principal Jain College of Engineering and Research, Belagavi, India

Abstract : This study Focuses on Differential scanning calorimetry results of Pure HDPE and Walnut Shell Particulates Reinforced HDPE composites (20,40 and 60 by Volume %) , DSC tests are carried out for all the composite specimens and pure HDPE specimen to know the temperature of phase transformation of all different compositions of HDPE and Walnut shell compositions which is necessary for optimizing the usage of pure HDPE.

IndexTerms **– Differential Scanning Calorimetry, HDPE, Walnut Shell Particulate Composites.**

1. INTRODUCTION

Composite have introduced extra ordinary fluidity to design engineering, in effect of forcing the designer-analyst to create a different material for each application as it pursues saving weight & cost". Nowadays material development is focusing on light weight, high stiffness, high strength and high fatigue resistance which is possible by composite materials. Composite materials play a vital role in optimum utilization of metals, plastics etc., in our daily needs. Researchers can develop a composite material by tailoring with polymers or metals with agricultural or industrial waste by altering their physical availability in nature like wood powder, industrial waste cenosphere etc., which adds the strength to matrix materials and helps in optimization of polymers and metal matrix. Researchers can optimize the usage of metals or polymers (like HDPE) utilization in our daily life by developing the particulate reinforced composites. Composite materials with HDPE as a matrix and marble and granite dust improves the thermal and mechanical properties of HDPE Composites [1] which may lead optimize the usage of HDPE, DSC analysis shows that Bio composites have high crystallinity than the virgin matrices [2], DSC Analysis plays vital role in determining the transition temperature of the polymers which is necessary for optimizing the injection molding parameters for manufacturing the polymers. HDPE/Cenosphere have been optimized and processed using injection molding machine [3], before composite DSC analysis of pure HDPE need to analyzed which will be able to understand the Process parameters like melting temperature and crystallinity temperature of Pure HDPE. [4,5], DSC and thermogravimetric analysis (TGA)methods are used to determine the thermal properties of the polyethylene-based composites [6]. DSC analysis can be used to obtain Isothermal crystallization temperature of HDPE which is helpful study of nucleation ability of HDPE.[7]

2. MATERIALS AND METHODS

HDPE Matrix: High density polyethylene is a Polyethylene thermoplastic made from petroleum, HDPE is known for its high strength to density ratio, The thermoplastic inorganic polymer of HDPE is selected as matrix constituent of grade HD50MA150 having 97,500 g/mol molecular weight. The resin is in pallet form having average diameter of 3 mm.

Particulates: Reinforcing agents are used to improve the mechanical properties of the matrix materials the walnut shell powder in the form of residue is being generated in the high proportions in the agro industries by grinding of the walnut shell, it is a light brown in color and the walnut shell powder is the renewable and unutilized agricultural material. Walnut shell powder is obtained by grinding the crushed shell in the grinding mill and also readily available in the market of different mesh size especially in the Jammu and Kashmir region in our study we are using the walnut shell powder of 80-100 mesh size which are very fine particles with the size 0.177mm - 0.149mm.

2.1 SAMPLE PREPARATION:

Blend of WS/HDPE prepared at 210°C by brabender mixing method. This blend is processed through industrial-polymer-single screw-injection molding (IM) machine with optimized proceess parameters [8] Three compositions of composite samples prepared

with 20, 40, and 60% by volume of WS particles. The nomenclature of prepared samples following Xyy (X – HDPE, yy – WS vol. %). Sample preparation bl°Ck diagram is as presented in

Figure 1.

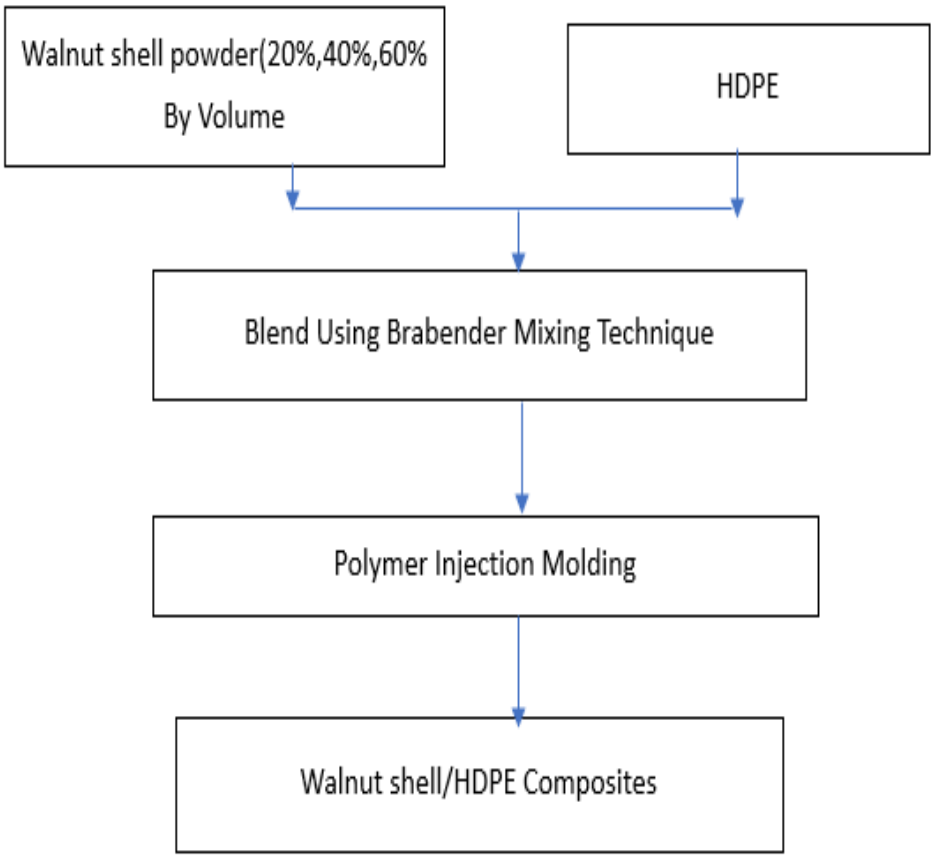

Figure 1 Processing route of Walnut shell/ HDPE composites.

2.2 DIFFERENTIAL SCANNING CALORIMETRY (DSC)

DSC is performed by Konspec Scientific Services Group Differential scanning calorimeter. About 8mg of samples sealed in aluminum pan were heated from 0°C to 200°C at a rate of 10°C/min, held at 200°C for 3 minutes then the samples were cooled to 200°C to 0°C at 10°C/min held at 0°C for 3 minutes, again the samples were heated from 0°C to 200°C at 10°C. This procedure was carried out under Nitrogen gas Differential scanning calorimeter test is performed to measure the properties such as specific heat capacity, temperature of phase changes like crystallization temperature, glass transition temperature and melting temperature of the composites.

3 .RESULTS AND DISCUSSIONS:

3.1 PURE HDPE SPECIMEN:

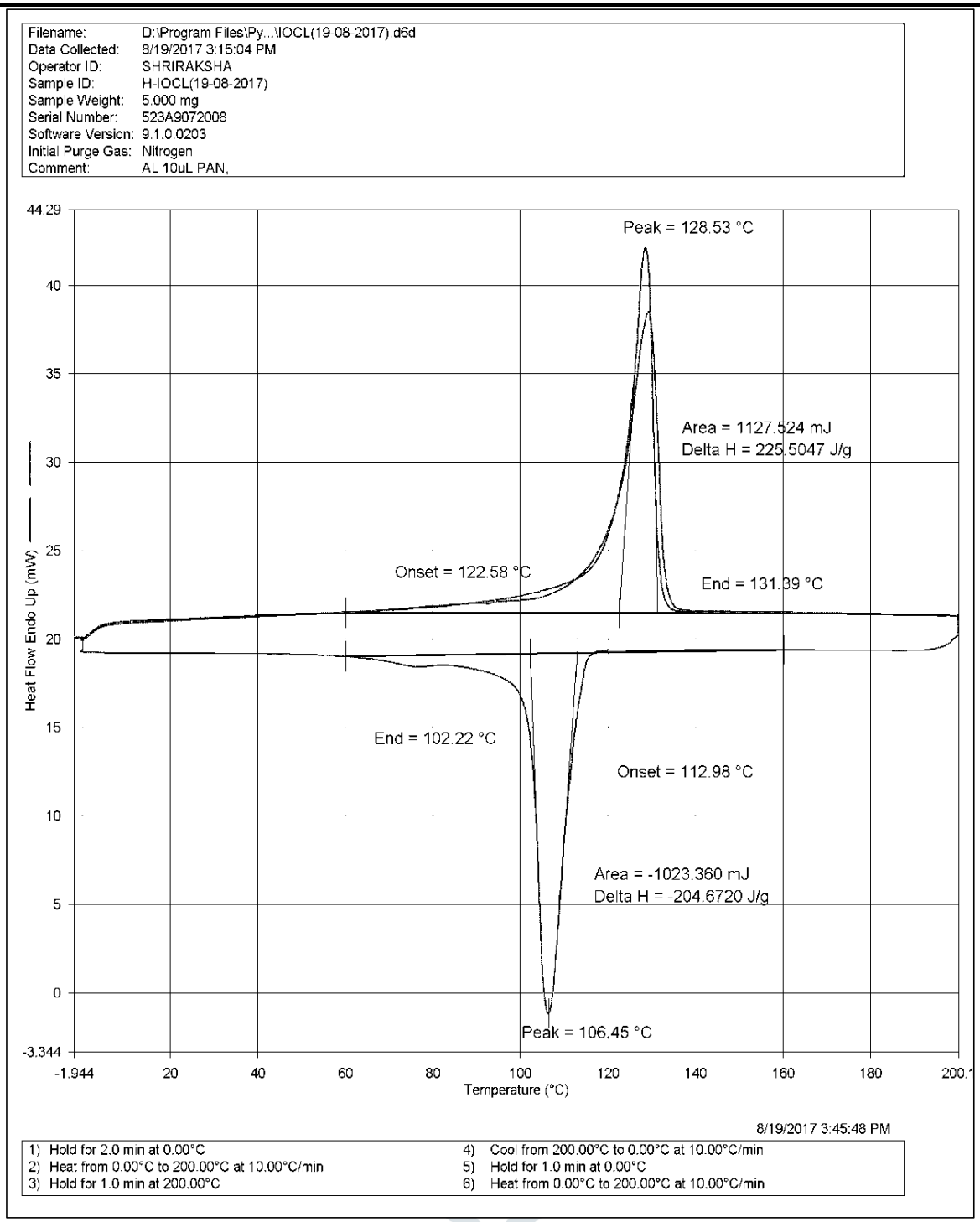

Figure 3.1 Differential Scanning Calorimetry results of Pure HDPE.

By the above DSC curve, it is observed that the Exothermic transition of the pure HDPE specimen is at 128.53 °C which represents the crystallization temperature whereas the glass transition temperature is at 122.58°C we can observe the area under the curve is 1127.525 MJ exothermic transition will end at 131.39°C . It is also observed that the Endothermic transition of the pure HDPE specimen is at 106.450°C which represents the melting temperature whereas Endothermic transition starts at 112.22°C we can observe the area under the curve is 1023.360 MJ exothermic transition will end at 102.22 °C.

3.2 H20 Specimen:

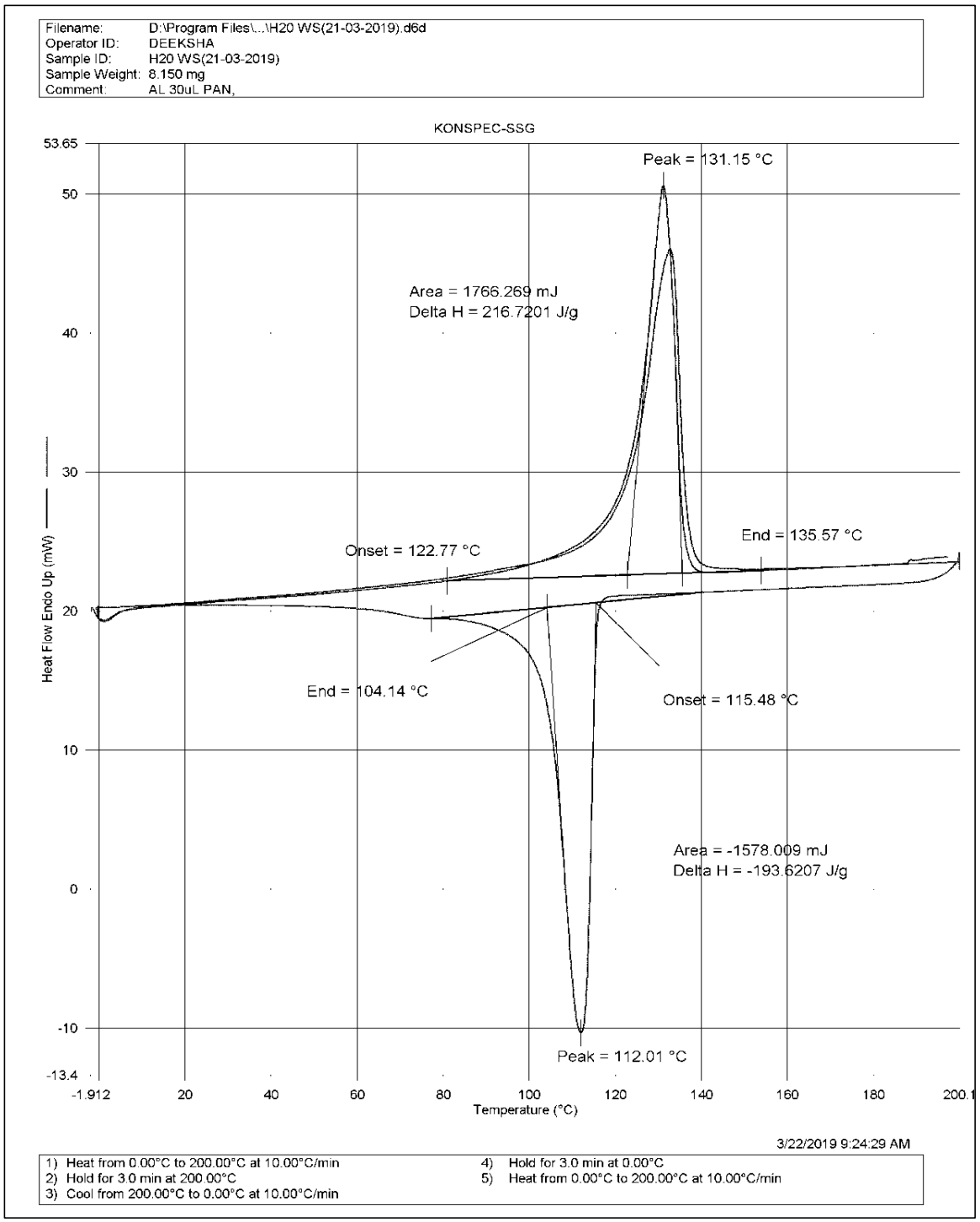

Figure 3.2 Differential Scanning Calorimetry results of H20 Specimen.

By the above DSC curve, it is observed that the Exothermic transition of the H-20 specimen is at 122.7 ℃ which represents the crystallization temperature whereas the glass transition temperature is at 131.5 ℃ we can observe the area under the curve is 1766.269 MJ exothermic transition will end at 135.57 ℃.It is also observed that the Endothermic transition of the H20 specimen is at 112.01 ℃ which represents the melting temperature whereas Endothermic transition starts at 115.48 ℃ we can observe the area under the curve is 1578.009 MJ exothermic transition will end at 104.14 ℃.

3.3 H40 Specimen

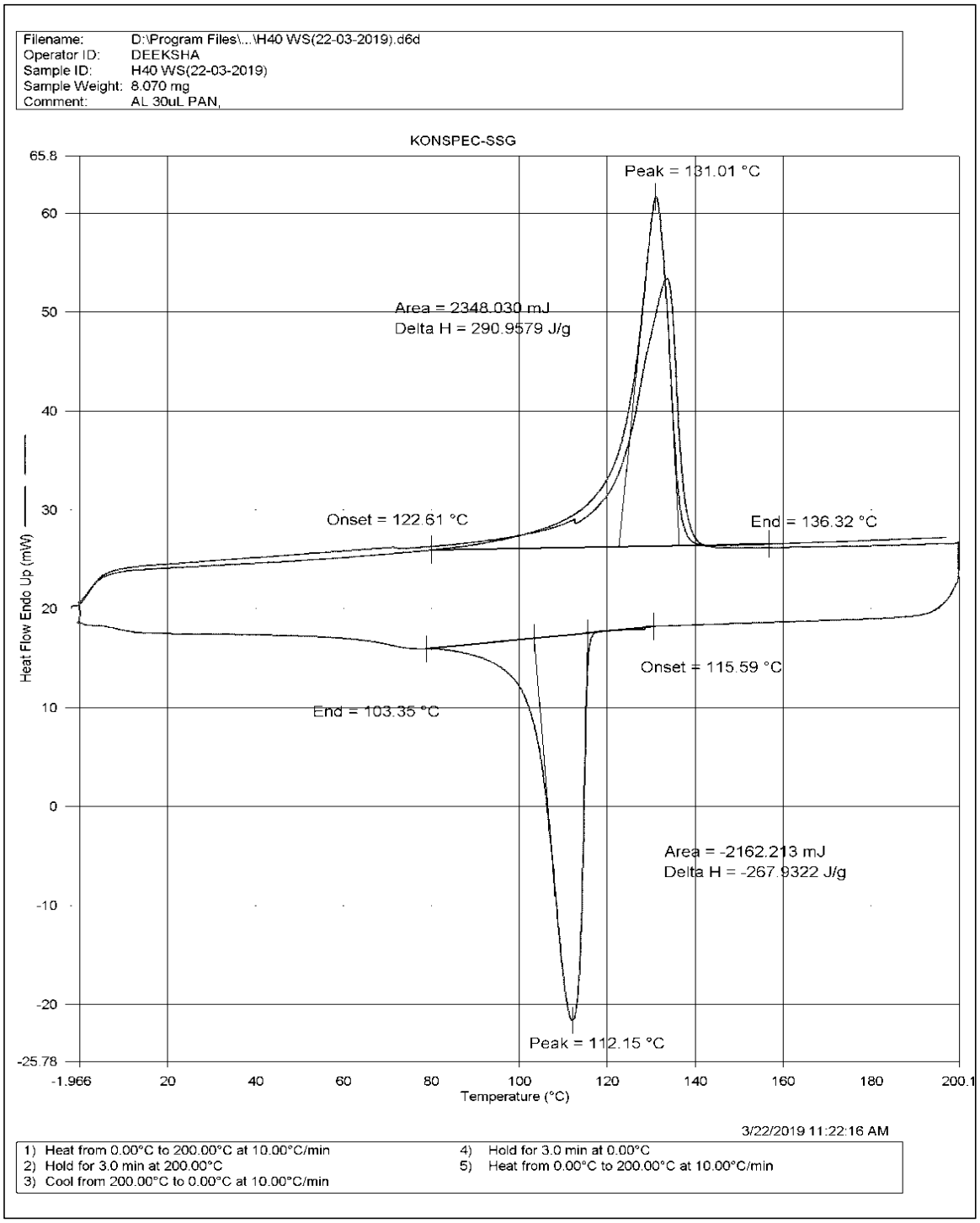

Figure 3.2 Differential Scanning Calorimetry results of H40 Specimen.

By the above DSC curve, it is observed that the exothermic transition of the H-40 specimen is at 122.61 ℃ which represents the crystallization temperature whereas the glass transition temperature is at 131.01 ℃ we can observe the area under the curve is 2348.030 MJ exothermic transitions will end at 136.32 ℃. It is also observed that the Endothermic transition of the pure HDPE specimen is at 115.59 ℃ which represents the melting temperature whereas Endothermic transition starts at 112.15 ℃ we can observe the area under the curve is 2162.9322 MJ exothermic transition will end at 103.35 ℃

3.4 H60 SPECIMEN

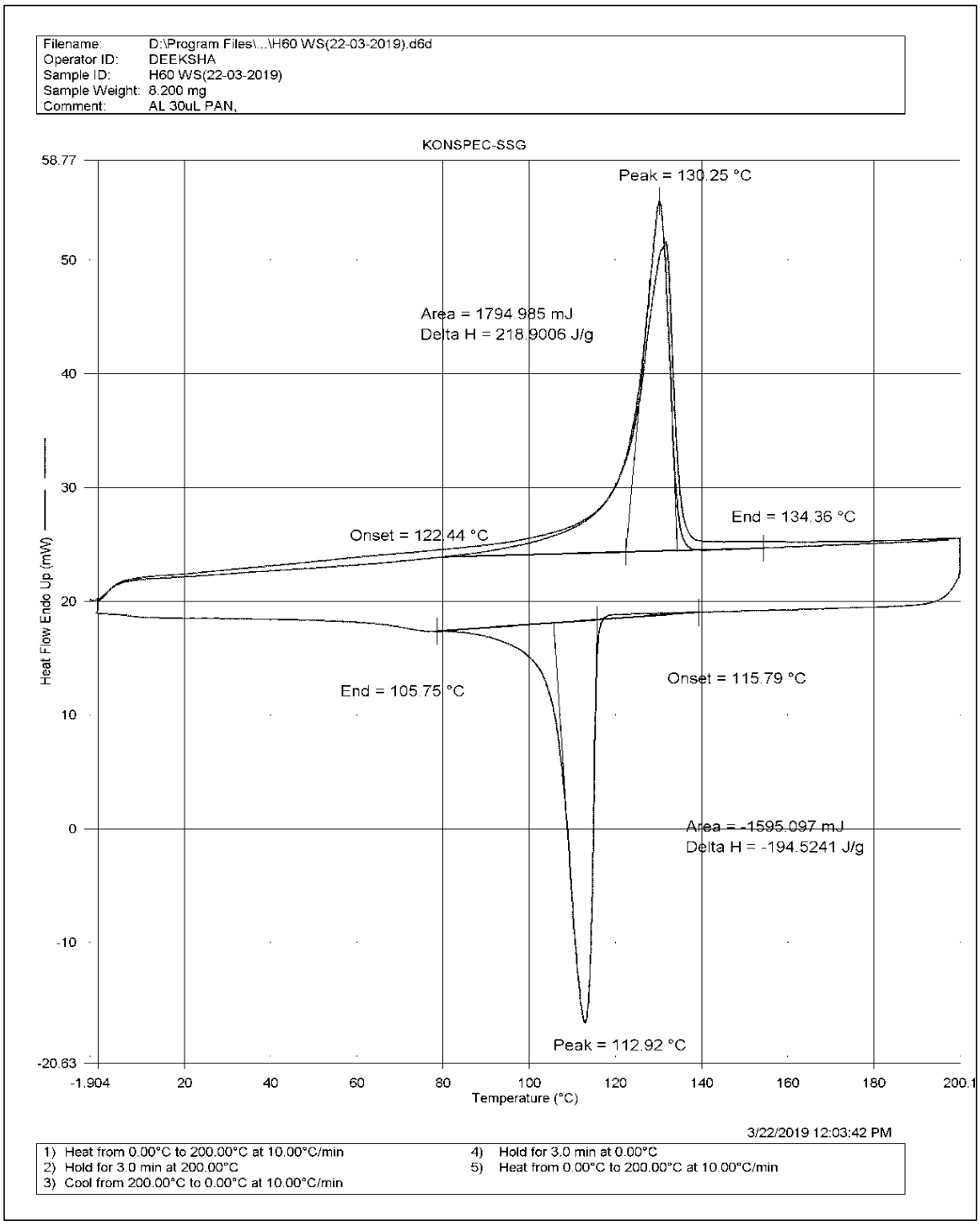

Figure 3.3 Differential Scanning Calorimetry results of H60 Specimen.

By the above DSC curve, it is observed that the Exothermic transition of the H-60 specimen is at 122.44 ℃ which represents the crystallization temperature whereas the glass transition temperature is at 130.25 ℃ we can observe the area under the curve is 1794.985 MJ exothermic transition will end at 134.36 ℃. It is also observed that the Endothermic transition of the pure HDPE specimen is at 115.79 ℃ which represents the melting temperature whereas Endothermic transition starts at 112.92 ℃ we can observe the area under the curve is 1595.097mJ exothermic transition will end at 105.75 ℃.

4. CONCLUSION:

Thermal Analysis DSC can be used to determine the crystallization temperature and Glass transition temperature of the composite materials. The crystallization temperature of the pure HDPE and composites are in the range of 122℃ to 128℃, Glass Transition temperature of the HDPE and composites lies between 122℃ to 130℃ and Melting temperature of the HDPE and composites lies between 106℃ to 115℃. The addition of Walnut shell particles into HDPE can optimize the utilization of HDPE Plastic and Eco-friendly composite material.

REFERENCES:

1. A.H. Awad, Ayman Aly Abd El-Wahab, Ramadan El-Gamsy , M. Hazem Abdel-latif et al " A study of some thermal and mechanical properties of HDPE blend with marble and granite dust" Ain Shams Engineering Journal Volume 10, Issue 2, June 2019, Pages 353-358.
2. Babacar Niang, Abdou Karim Farota, Abdoul Karim Mbodji , Nicola Schiavone , Haroutioun Askanian , Vincent Verney , Abdoulaye Bouya Diop , Diène Ndiaye , Bouya Diop "Comparative Study of Differential Scanning Calorimetry (DSC) Analysis and Rheology of HDPE-Typha and PLA-Typha Biocomposites and Photo-Aging of HDPE-Typha Biocomposites" International Journal of Composite Materials 2022, 12(1): 1-9 DOI: 10.5923/j.cmaterials.20221201.01.
3. B.R. Bharath Kumar, Mrityunjay Doddamani, Steven E. Zeltmann , Nikhil Gupta , M.R. Ramesh, Seeram Ramakrishna "Processing of cenosphere/HDPE syntactic foams using an industrial scale polymer injection molding machine" Materials and Design 92 (2016) 414–423. journal homepage: www.elsevier.com/locate/matdes.
4. Luiz Fabio de Oliveira Junior, Zarur Silvano, Pedro Martins Rocha "Thermal Analysis of Differential Scan-DSC Calorimetry for the Pure High-Density Polyethylene and Its Variables" International Journal of Engineering Trends and Technology (IJETT) – Volume 65 Number2 - November 2018.
5. Subrata Mukherjee ,Sandip Pal Chowdhuri ,Arunava Mandal ,Sandip Pan ,Achintya K.Saha " Effect of High Energy Electron Irradiation on HDPE and LDPE Studied by Differential Scanning Calorimetry (DSC)" International Journal Of Engineering Research and Technology (IJERT) AMRP-2013 Conference Proceedings.
6. P. Noorunnisa Khanam and Mariam Al Ali Al Maadeed " Processing and characterization of polyethylene-based composites" Advanced Manufacturing: Polymer & Composites Science, 1:2, 63-79, DOI: 10.1179/2055035915Y.0000000002.
7. M.Bonnet, J.Loos, J.Peterman ".On the crystallization of syndiotactic polypropylene (sPP)/high density polyethylene (HDPE) blends" Colloid and Polymer Science volume 276, pages524–528 (1998).
8. Bharath Kumar, B.R., M. Doddamani, S.E. Zeltmann, N. Gupta, M.R. Ramesh, and S. Ramakrishna, Processing of cenosphere/HDPE syntactic foams using an industrial scale polymer injection molding machine. Materials & Design, 2016. 92: p. 414-423