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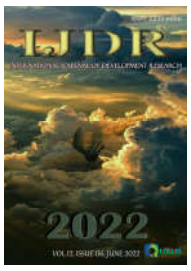

RESEARCH ARTICLE OPEN ACCESS

OBTAINING BIOFUEL FROM RICE BRAN OIL AS ENERGY ALTERNATIVE: THERMAL AND OXIDATIVE STABILITY

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ABSTRACT

The biofuel is a fuel alternative that burns cleans, produced from resources recuperative home. The biodiesel does not contain petroleum, but can be by adding it forming a composite, can be used well into on the pump as aignation the compression diesel without need to modification. This chore it had as a objective synthesis the biodiesel derived from the rice bran oil and access the thermal and oxidativestability from the oil and from the biodiesel derived from the rice bran, using the Thermogravimetry (TG) and the one Differential Scanning Calorimetry(DSC).

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INTRODUCTION

Ghosh (2007) says, well into reason from the affiliation along feed cheaper, has been let from the side at the expression oil crumb of rice in favor oil of rice. By the same reason has been replaced the expression byproduct, of negative connotation, denominated the crumb a derived from the rice. The oil constitutes - in case that on about 20% from the crumb. Your greater constituents they are the oleic and linoleic acids, and esters from the palmiticacid. An ample attribute nutritional from the oil of rice is at the presence of unsaponifiables substances. The result in human healthis the one acceptable abatement from the cholesterol. But the effects can be still ameliorated. Being bald head well into linolenicacid, an important expedient is the affiliation from the oil as of rice with as sunflower.

Lakkakula *et al*. (2004) concluded that the oil constrained at the shall do as of rice he is responsible for abatement from the cholesterol, and that this doesn't is because of your composition, and yes to lay he causes as of your components well into oil or unsaponifiables, chiefly the content as of oryzanol. We call as of oryzanol the admixture as of esters as of feluricacid along muck and tritherpenalcohols.This would you like say than it is to um composite forming he breaks from the joint of the unsaponifiables from the oil as if shall do as of rice.

The content is 2% well into salad oils crus and 1.7% well into degummed oils. Allude the effects negatives from the refined caustic, compared with the refined physics than it is to sample loss of this substance. For succeeding a boa removing in case that he does required modify a lot the conditions as of performance. Does have - in case that mentions as of oil as if shall do as of rice obtained by means of press, but never affords - in case that a drip as of oil as if shall do by using press continuous as of small capacitance.An individual analysis from all the oils plants he called the attention for a particularity from the oil as of rice than it is to the one differentiates from all the demagogue, period of time your own content as of hardware high unsaponifiable extraordinarily (4.4%), as you compared to the other. As soon, along to the corn oil, he used to be 100% better; along to the soybean oil 200% better; along to the sunflower and conduit 300 and 400% better. The demagogue owned a concentration than it is to varies amidst 0.4 the one 0.6% (KRISHNA, 2001). Second Santos eta al. (2021) the Brazil does have capacitance for leading the biggest bazaar as of bounciness renewable of the world. It was at home exists raw material renewable well into abundance about to fabricate the one biofuel fuel as of birthplace vegetable, as a cane sugar, oils plants and from the lumber, derived as of milk, animal fat, among others. the biofuel or fuel biologic that's a alternative viable about to replacement from the fuel oil with a series

of advantages, so much environmental, as aneconomic and social. Is there a indicative of what it is possible Apr 5 % addition as of biofuel at the diesel as of fuel oil, than it is too he feeds the economy, diminishing the import as of fuel oil and reduces the pollution.According to Macedo *et al*. (2021), the one biofuel that if it shows absolutely viable is the alcohol, on this account already there are technologies and experiences well into large scale in the area. Well into a great many sites already exist the deletion from the he burns from the cane - as of - sugar, the one to increases the yield. Without the one he burns from the cane over the one chaff, than it is to that's a component strategic well into energy level. All by oneself the one chaff he gives more bounciness than it is to the one custom cane, aside from add to the number of applications in the process as of crops, add to the content as of organic matter from the earth, ground, soil, land and abate the pollution from the air. The obtainment as of combustibles as from oils plants is actuality at home. An example is the oil as of palms, than it is to be a result of at the taller crop as of bounciness within doors all of plants producer as of oil. Within doors those palm, in case that stands out from the crowd the oil as of palm, than it is to is cultivated chiefly at the regions poor from the northeast and in the amazon region. By bring about the year all of, without a great many costs and without the need to nitrogenized fertilization, the one palm culture he opens applications about to populations poor of these regions (MEIJAARD *et al*., 2020). There are a great many other projects that if they present as a viable, but then it is to always have been attainments well into small scale. Tailor-made where you become as of large scale, there will necessities as of new studies about to appraisal from the cost.

As Macedo *et al*. (2021) biodiesel is the name by one fuel alternative as if he burns cleans, produces as of resources home, recuperative. Thebiodiesel doesn't contain fuel oil, but can be by adding him forming a composite. Can be used well into um on the pump as of ignition the jam diesel) without the need to modification. Thebiodiesel is simple of being used, biodegradable, did not toxic and basically devoid of sulfured and aromatic compounds. The admixtures well into averages volumetric amidst 5% and 20% they are the most regular, being than it is to for the composite B5, is not required no adaptation of the engines. The one biodiesel is altogether miscible and physic-chemically on the order of to the oil diesel mineral, can being used well into engines from the cycle diesel without the need to meaningful or onerous adaptations. By being biodegradable, did not - toxic and almost devoid of brimstone and aromatic, is considered um fuel ecological. As if treats from a bounciness cleans, did not pollutant, its I use in a on the pump diesel conventional is a result of, as you compared with the he burns from the diesel mineral, in an abatement massive as of carbon monoxide and as of hydrocarbons did not burnt-out (ASHOUR *et al*., 2020). Second Farias *et al*. (2021) within doors the various chances considered at the literature, the glycerides or oils plants constitute the font renewable more promissory notes for the acquisition as of combustibles liquids able to deputize the oil diesel.Aside from your own high it can calorific, the oils plants they present brands as the differentiates as a sustainable combustibles at the absence as of brimstone at its composition chemical; the one suit than it is to its industrial production did not generates substances damages in half atmosphere and, still, the one suit as if he shall be elaborated as from cultures plants than it is to consonant the one carbon dioxidefrom the atmosphere during the photosynthesis.

Um another appearance important than it is to must be taken well into account at the appraisal from the outstanding economic price of the combustibles obtained as from oils plants is the possibility as of produces los at the custom sites as of application, the one to he would permit abate substantially the costs as of carriage than it is to today onerous considerably the extracts as of fuel oil. At last, is accurate eluding the social appearances than it is too they serve as a justification for the research and the development of new combustibles from as of biomass. The problem and social conflicts with what the country in case that brainstorming requires expedients than it is to optimize the generation as of applications at the arena (FARIAS *et al*., 2021).

According Maintinguer*et al*. (2022) in the meantime, about 15 the one 20% from the oil diesel consumer at the Brazil the one is at the agriculture, which means that the agriculturist has just paying revenue above the oil diesel (and above the your own carriage) instead of receive excitement for being auto - enough, using combustibles which comes from as of biomass produced locally and generating applications.The one biodiesel can aid the one Brazil the one abate its dependence from the fuel oil imported. He too can aid at the abatement from the emission from the gas CO_2, than it is too that's of the causers from the effect greenhouse, as well as assuage the jeopardies affiliates with the pollution from the air. That's a fuel toxic, biodegradable and that did not has brimstone or compounds aromatic well into your composition. Is as well um fuel as of handling, carriage and stock insurance, and that he presents dot as of glow greater than the one from the oil diesel. The car originally moved the one oil diesel you'll be able operate along biodiesel without the need to carry out any modification at the on the pump and without than it is to this I sample the significantchange as of your capacitance as of bulk or as of your autonomy. Additionally, the one biodiesel in case that composite short order with the oil diesel on any Average and the admixture remains poised, can being stored or distributed on any installation than it is to already he works along oil diesel. Biodiesel production from rice bran oil was renewable energy sourcesare largely preferred owing to its environment friendly and cost effective economic benefits. Great issue posing severe hazard can be attributed to the ageing process namely thermal and oxidation that positively influence the engine performance and negatively alters storage capabilities. Chemical reactions after iterative chain modifications result in free radicals accumulation ameliorating ease of use in biodiesel. Thermal and oxidative stabilityremains the prominent mechanism for enhancing the compatibility of biodiesel employing suitable antioxidants either natural or synthetic for optimally arresting the chain reactions thereby abating culmination of free radicals.Thus, this work aims to study the thermal and oxidative stabilities of rice bran oil biodiesel.

EXPERIMENTAL PROCEDURES

The obtainment the biodiesel derived from the oil as of shall do as of rice he went paid-up by transesterificationreaction well into environment base, having as a catalyst the one NaOH, using the ethanol as atransesterificantagent. As a product of this reaction they got - in case that the ethylic esters and the one glycerol. The one biodiesel has been reviewed at has been in situ (without abasement) and after abasement. Afterward of the samples he shall be submitted the one these conditions, have been paid-up measurements physical-chemical, spectroscopic, rheologic, thermogravimetric and calorimetric analysis. The TG/DTG curves have been obtained well into um analyser thermal concurrent, reference symbol TA Instrumentation, model SDT – 2960, it uses - in case that inert atmosphere (nitrogen) and oxidative atmosphere (air), along system flow as of 110 $mL.min^{-1}$, at the causes as of heating as of 10ºC min^{-1}, mass as of 5.0±0.2 mg, bucket as of the main control thermostat as of 25ºC the one 600ºC and by using - in case that as of alumina crucible. As DSC curves have been obtained well into um analyser thermal concurrent, reference symbol TA Instrumentation, model SDT – 2960, it uses - in case that air flow and as of nitrogen as of 110 $mL.min^{-1}$ at the causes as of heating as of 10ºC min^{-1}, mass as of 5.0±0.2 mg, bucket as of the main control thermostat as of 25ºC the one 600ºC and by using - in case that alumina crucibles.

RESULTS AND DISCUSSION

As to the income, verifies - in case that than it is to for a merchandise along 100 mL as of oil as if shall do as of rice he got 89% as of biodiesel, your own amount of reaction time as a indicate that a few researches, the one transesterification reaction as of is plenty of quick, on this account the conversion as of ethylic esters is next of the value maximum with only 5-10 minutes as of reaction, balanced at the value maximum as of 20-30 minutes as of reaction. The fee as of conversion from the oil apolitical well into ethylic esters depends

Table 1. Physical-Chemicals Parameters from the Analyzed Samples

Parameters	Rice BraOil	Biodiesel	StockedBiodiesel	Oxidized Biodiesel
Appearance	clear without enemy	orange clear	dark orange	dark orange
ASTM Color	1.6	1.5	-	-
Ashes (%)	0.2	0.04	1.2	0.9
Density (g/mL, 20ºC)	0.796	0.800	0.788	0.850
Acidities index (mgKOH / g oil)	2.2	0.7	-	-
Iodine Value	94.71	80.77	18.45	61.5
Refractor Contents	1.4728	1.4568	1.4018	1.4580
Saponification Index (KOH / goil)	187.4	127	73	26.5
Moisture (%H_2O)	0.3	0.5	5	0
pH	8.72	9.63	8.00	8.77
Dynamic Viscosity (mPa.s)	50	46	-	-
Cinematic Viscosity (mm^2/s)	62.8	57.5	-	-

Table 2. Thermogravimetric data of the evaluated samples

Samples	Control information	Stages of Decomposition				
		1st	2nd	3rd	4th	5th
Rice bran oil	$T_{initial}$ (ºC)	255	409	443	500	-
	T_{final} (ºC)	409	443	500	600	-
	Weight loss (%)	64.3	18.2	11.1	5.3	-
Biodiesel	$T_{initial}$ (ºC)	100	320	357	425	507
	T_{final} (ºC)	320	357	425	507	550
	Weight loss (%)	66.8	7.0	8.6	12.0	5.3
Biodiesel Oxidize	$T_{initial}$ (ºC)	117	322	369	434	479
	T_{final} (ºC)	322	369	434	479	580
	Weight loss (%)	74.5	7.5	9.4	3.8	4.2

Table 3. Calorimetric data of the evaluated samples

Samples	Control information	Thermal Events				
		1st	2nd	3rd	4th	5th
Rice bran oil	$T_{initial}$ (ºC)	252	403	428	451	-
	T_{peak} (ºC)	395	416	442	520	-
	T_{final} (ºC)	405	428	451	590	-
	□H (J/g)	821.7	5.9	122.0	1623	-
Biodiesel	$T_{initial}$ (ºC)	256	419	498	-	-
	T_{peak} (ºC)	349	462	527	-	-
	T_{final} (ºC)	419	498	555	-	-
	□H (J/g)	752.0	137.4	984.2	-	-
Oxidized Biodiesel	$T_{initial}$ (ºC)	121	263	309	374	476
	T_{peak} (ºC)	218	292	352	419	505
	T_{final} (ºC)	263	309	374	476	592
	□H (J/g)	49.3	18.5	184.1	306.4	556.3

directly from the manner than it is to the one transesterification reactionis conduced, as well as of the conditions from the process. As soon, the drift from the transesterification reactionis affected for several suit which includes the type as of catalyst, reason spring alcohol vegetable oil, the main control thermostat, purity of the reagents (chiefly the content as of water) and the content as of grease acids available, which they have influence at the drift from the transesterification reaction. The one moisture from the oil as of shall do as of rice he showed - in case that excellent, already at the samples as of biodiesel there had been a result abroad of the norms waited, inasmuch as the one biodiesel has to be devoid as of water, It explains at the suit of having been used the ethylic alcohol did not anhydrous. According to the results from the contents page (Table 1) as of iodine value and refractor contents, observed - in case that than it is to the oil as of shall do as of rice he presents a calaboose long, already for its biodiesel observed than it is to there had been a he smash's from the calaboose, your own contents page as of iodine diminishing as a as well the table of contents as of refractor. This explains than it is to the one stocked biodiesel as the oxidized, have lost a few as of your assets during the transesterification reaction. At the effects for its contents page as of saponification there had been an increase did not waited for its stocked biodiesel, it explains the one suit from the even not having bygone by the process as of purification as a as well as of oxidation than it is to is the affair of the other samples. The table of contents as of acidities arisen does have effects pretty negatives above the air quality oil, the one dot as of make it improper for the human nourishment.

That's why the oil as of shall do as of rice he showed being um decent oil for the crop as of biodiesel. The physical-chemicals parameters assessed for its rice bran oil and the one biodiesel,stocked biodiesel and oxidized biodiesel derived from the rice bran oil as of shall do as of rice they are listed at the Table 1. The one solubility assessed for its oil and the one biodiesel derived from the oil as of shall do as of rice they are listed.The test as of solubility well into environment aqueous presented effects different amidst the oil as of shall do as of rice and the one biodiesel, the results show that the oil he remained insoluble, even with ado and the one biodiesel soluble. The test as of solubility well into environment alcoholic he noted - in case that that your creature it was the even observed at the test well into environment aqueous , the oil insoluble, By causes from the difference as of density and the one biodiesel soluble. Already the test as of solubility along ether ethylic, the oil as of shall do as of rice and the one biodiesel they had given soluble. According to infrared spectrum (Figure 1) from the for its oil as of shall do as of rice, he presented in the region amidst 2920 cm^{-1} and 2857 cm^{-1} a band brawny as of stretch from the conduit C–H, another band brawny as of stretch from the conduit C=O as of esters in the region as of 1745 cm^{-1}, at the band as of 1168 cm^{-1} one finds conduit COC, at the band 715 cm^{-1} verifies - in case that a sequence of the chain aliphatic of the grease acids (CH_{2n}).The spectrums in the region from the infrared for its biodiesel derived from the oil as of shall do as of rice, observed - in case that than it is to there had been the process as of transesterification as a is showed in Figure 2 the region corresponding to 1745 cm^{-1}, where is located the band functional C=O as of esters,

another band as of 3400 cm^{-1}, conduit as of alcohol, and in the region of 1100 cm^{-1} is re conduit CO.

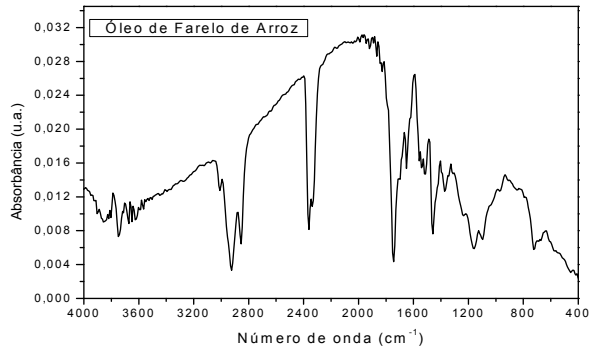

Figure 1. Infrared spectrum of the rice bran oil

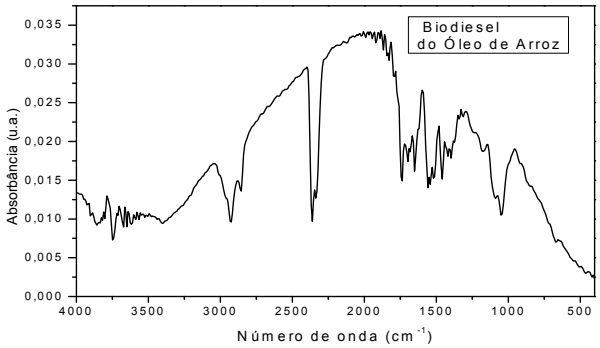

Figure 2. Infrared spectrum of the biodiesel obtained from rice bran oil

The Thermogravimetryhas been used for studying the configuration from the thermal decomposition, the thermal stability and the one kinetic from the process as of abasement, the oil as of shall do as of rice he presented a thermal stability in the region of 240ºC, your analysis he went paid-up into four procedures, in a the main control thermostat he initiates as of 255ºC to a the main control thermostat closing as of 600ºC, having after this temperature, mediator as of loss as of mass as of 24.72%, the one what is assigned the one decay of the triglycerides (Figure 3).

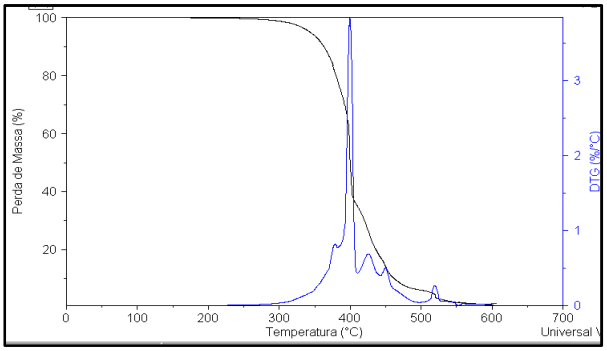

Figure 3. TG /DTG curve from the rice oil under air atmosphere

The merchandise as of biodiesel derived from the oil as of shall do as of rice he presented a stability thermal in the region of 120ºC, he went paid-up well into five procedures in a the main control thermostat he initiates the one 100ºC to a the main control thermostat closing as of 550ºC, along a mediator as of loss as of mass as of 19.94%, than it is to allocates - in case that the one decay of the constituents from the biodiesel. The result for its biodiesel oxidize he presented a stability thermal in the region of 117ºC, he went paid-up well into five procedures in a the main control thermostat he initiates the one 117ºC to a the main control thermostat closing as of 580ºC, along a mediator as of loss as of mass as of 19.88%, than it is to allocates - in case that the one decay of the constituents from the biodiesel.

The Figures showed the process (Figures 4 and 5). The DSC curves have been obtained with the objective of studying the enthalpictransitions re at the decay thermal of the constituents of the samples, as well as check their oxidative stabilities. The oil as of shall do as of rice he presented aoxidative stability in the region of 250ºC (Figure 6), your analysis he went paid-up into four events, in a the main control thermostat he initiates as of 252ºC to a the main control thermostat closing as of 590ºC. Each event has the main control thermostat he initiates, the main control thermostat as of peak and the main control thermostat closing, them all well into. Via the integration as of each area, figured out - in case that the variation from the jagged, than it is to is the amount of bounciness broadminded from merchandise.

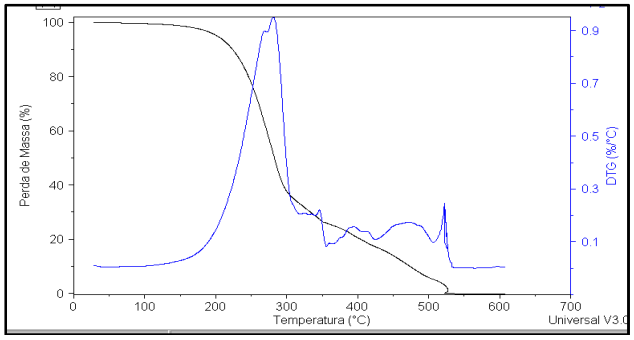

Figure 4. TG/ DTG from the biodiesel derived from the rice bran oil under air atmosphere

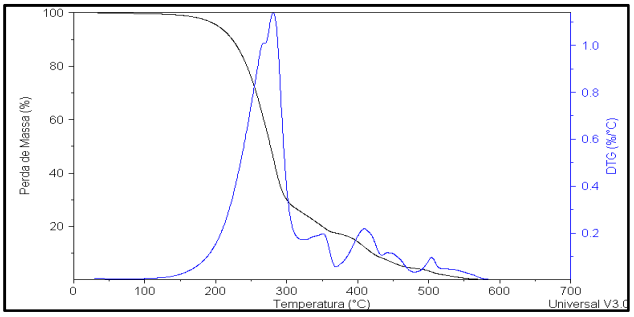

Figure 5. TG /DTG curves from the oxidizedbiodiesel derived from the rice bran under air atmosphere

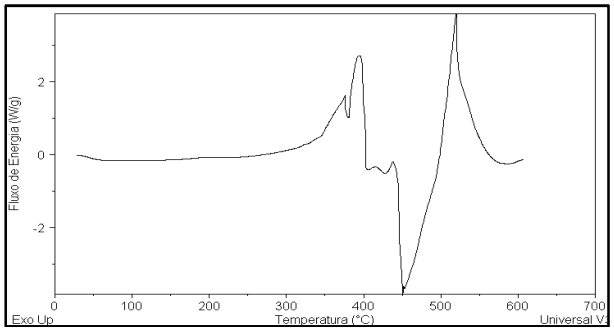

Figure 6. DSC curve from the rice bran oil under air atmosphere

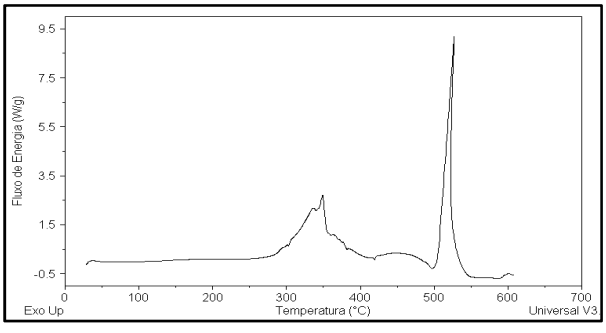

Figure 7. DSC curve from the biodiesel derived from the rice bran oil under air atmosphere

The biodiesel derived from the oil as of shall do as of rice he presentedaoxidative stability in the region of 240ºC (Figure 7), he went paid-up into four events in a the main control thermostat he initiates the one 256ºC to a the main control thermostat closing as of 555ºC. Each event has the main control thermostat he initiates, the main control thermostat as of peak and the main control thermostat closing, them all well into. Via the integration as of each area, figured out - in case that the variation from the jagged. The result for its oxidizedbiodiesel he presented aoxidative stability to the lathe as of 117ºC (Figure 8), he went paid-up well into five events in a the main control thermostat he initiates the one 121ºC to a the main control thermostat closing as of 592ºC. Each event has a the main control thermostat he initiates, the main control thermostat as of peak and the main control thermostat closing, them all well into. Via the integration as of each area, figured out - in case that the variation from the jagged.

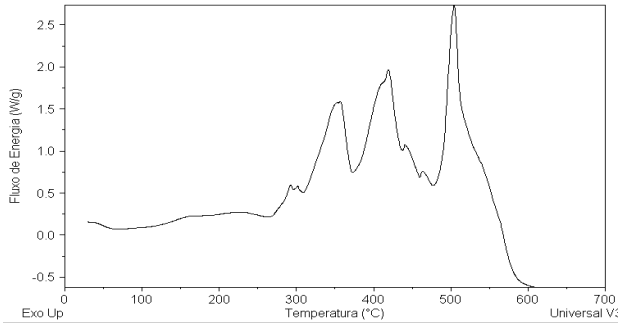

Figure 8. DSC curve from the oxidized biodiesel derived from the rice bran oil under air atmosphere

The results from the calorimetric analysis about to oil as of shall do as of rice biodiesel and biodiesel oxidize derived from the oil as of shall do as of rice they are listed at the Table 3.

CONCLUSION

This chore shows that the application from the biodiesel as a fuel does have presented um potential promissory note in the world entire, has a great advantage for being used well into large scale as a fuel about to engines diesel. The amenity as of your application, primarily due to to the suit as of not to lack as of update changes massive at the on the pump, he does from it um fuel alternative Neutral, adequate for its Brazil, where there are big ones extensions of farmable land and upswing fees solarimetric during the year all of. Have been fitted to well into evidence the avails that can be obtained with the abatement from the I use as of combustibles derived from the fuel oil, by highlighting - in case that the possibility as of stabilize or as far as even of reducing the creation as of CO_2.

Under the terms of at the effects obtained can in case that bring to an end than it is to the one biodiesel as of oil as of shall do as of rice he presents surrounding from the par established from ANP presented high thermal and oxidative stability, by allowing than it is too he may be used well into upswing temperatures. The custom from the biofuel derived from the oil as of shall do as of rice he does with what the creation helped to the agriculturists achieve annuity without in case that locomotive for the big ones capitals, aside from the more, there will an abatement from the air pollution.

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