PERFORMANCE AND EMISSIONS CHARACTERISTICS OF PALM OIL BIODIESEL BLENDED WITH DIESEL AND ADDITION OF DIETHYL ETHER ON COMPUTERIZED VCR ENGINE

[1]Mr. Vinodh.CH, [2]Dr. R Sam Sukumar, [3]Prof. A Ramakrishna
[1]Assistant Professor, Department of Mechanical Engineering, Sri venkateswara institute of science and information technology,Tadepalligudam, Andhra Pradesh, India.

[2]Associate Professor, Department of Mechanical Engineering, Swarnandra college of Engineering and Technology, Narsapur, Andhra Pradesh, India

[3]Department of Mechanical Engineering, Bonam Venkata Chalamaih Engineering College, Odalarevu, Andhra Pradesh, India
([1]Vinodh613@gmail.com,[2]Samsukumar7@gmail.com)

Abstract-Palm oil/palm oil methyl esters are blends with diesel fuel, the blends were characterized as an alternative fuels for diesel engines Palm oil and palm oil biodiesel were blended with diesel. Performance and emission tests were conducted on variable compression ratio diesel engine coupled with eddy current dynamometer with the help of multi gas analyzer.Blend B20 of Biodiesel has been carried out throughout the experiment at different compression ratios namely CR 16 ,CR 17, CR 18 and diesel (D100) at 17.5. Finally DEE (Diethyl Ether) additive mixture added to blend B20 and plotted graphs between B20 ,B20+DEEand D100 for performance and emissions at different compressions ratios. Emissions of the bio diesel (palm oil+ DEE) has been reduced and performances of the engine are improved as compared with conventional diesel fuel engine.
Keywords-*B20, D100;compression ratio (CR); Blend; Trans-esterification, efficiency.*

Nomenclature-

IP – indicated power in KW
BP- break power in KW
FP – frictional power in KW
ηmech – mechanical efficiency (%)
ηbth- break thermal efficiency (%)
ηvol- volumetric efficiency (%)
ηith- indicated thermal efficiency (%)
A/F ratio – air fuel ratio
SFC – specific fuel consumption (Kg/Kw-hr)
IMEP – Indicative mean effective pressure in Bar
BMEP – Break mean effective Pressure in Bar

I. INTRODUCTION

The twenty-first century introduced an era of increased global petroleum demand that has not been met with an increase in oil production. The only way to insulate the economy from petroleum price shocks is to lower the dependence on petroleum in the economy. The most practical and least disruptive strategy to achieve this objective is to use alternative fuels. Increased use of renewable and alternative fuels can extend fossil fuel supplies and help resolve air pollution problems inherent in automotive use of conventional fuels. Present IC engines are one of the most prominent factors for climate change as they release sufficient amount of greenhouse gases like Carbon Dioxide, Nitrous Oxide, Water vapour and atmospheric pollutants like Carbon monoxide, Hydrocarbons, Sulphur dioxide, Particulate Matters etc. However, more improvements are needs to bring down the ever-increasing air pollution due to automobile population. Alternative fuels with properties comparable to petroleum based fuels. These fuels should be easily available at low cost, be environment friendly and fulfil energy security needs without sacrificing engine's operational performance. Fuels like alcohol, biodiesel, liquid fuel from plastics etc. are some of the alternative fuels for the internal combustion engines.

II. LITERATURE

As a part of literature review extensive studies were carried out on many research papers published by the researchers around the world, who has use different vegetable and animal fatty oils as an alternative fuels without any modification in the Variable Compression Ratio diesel engine and some of them are analyzed and discussed below.

V.I.E. Ajiwe, V.O. Ajibola, C.M.A.O. Martins- Biodiesel fuels from palm oil palm
oil methyl ester and ester-diesel blends, Chem. Soc. Ethiop. 17 (1) (2003) 19–26.

T. VenkateswaraRaoet al, used methyl ester of Pongamia (PME), Jatropha (JME) and Neem (NME), are derived through trans-esterification process and evaluate the performance and emission of different blends (B10, B20 and B40) of PME, JME and NME in comparison to diesel. Result indicated that B20 have closer performance to diesel. However its blend showed reasonable efficiencies, lower smoke, CO and HC.

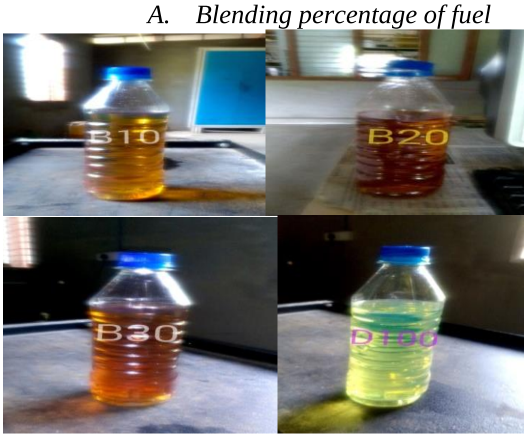
Panda et al, described that production of liquid fuel from jatropha biodiesel would be a better alternative as the calorific value is comparable to that of fuels, around 40 MJ/kg. This option also reduces waste and conserves natural resources.

Rajneesh Kumar et al, Prepared Jatropha methyl oil ester (JMOE) as a diesel fuel substitute. In this study, emission and combustion characteristics were studied when the engine operated using the different blends (B10, B20, B30 and B40) and normal diesel fuel as well as when varying the compression ratio from 16.5:1 to 17.5:1 to 18.5:1.

C.L. Peterson, D.L. Reece, B.J. Hammond, J.C. Thompson, S. Beck ,Commercialization of Idaho biodiesel (HYSEE) from ethanol and waste
vegetable oil. ASAE Paper No. 956738, St. Joseph, MI: ASAE, 1995.

III. EXPERIMENTAL SETUP

A. Blending percentage of fuel



Notation	Fuel Quantity	Palm Oli Biodiesel	Diesel Quantity
B10	1 litre fuel	100 ml	900 ml
B20	1 litre fuel	200 ml	800 ml
B30	1 litre fuel	300 ml	700 ml

VCR Diesel Engine

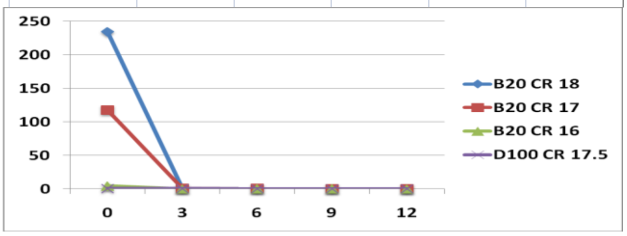
B. Description

The setup consists of single cylinder, four stroke, VCR (Variable Compression Ratio) Diesel engine connected to eddy current type dynamometer for loading. The compression ratio can be changed without altering the combustion chamber geometry by specially designed tilting cylinder block arrangement. The set-up has consisting of air box, two fuel tanks for duel fuel test, manometer, fuel measuring unit, transmitters for air and fuel flow measurements, process indicator and engine indicator. Rota meters are provided for cooling water and calorimeter water flow measurement. The setup enables study of VCR engine performance for brake power, indicated power, frictional power, BMEP, IMEP, brake thermal efficiency, indicated thermal efficiency, Mechanical efficiency, volumetric efficiency, specific fuel consumption, A/F ratio and heat balance.

IV. EXPERIMENTAL RESULTS

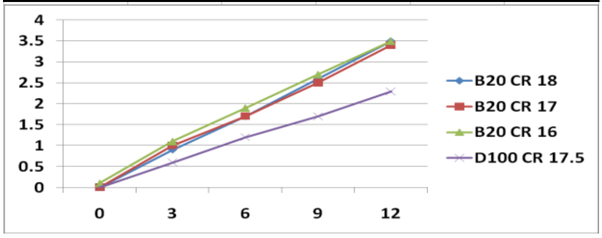
A. B20 and D100 at Various Compression ratios:

LOAD	0	3	6	9	12
B20 CR 18	234.43	0.79	0.49	0.4	0.36
B20 CR 17	117.35	0.72	0.5	0.41	0.37
B20 CR 16	4.7	0.33	0.42	0.42	0.27
D100 CR 17.5	0.86	0.74	0.46	0.38	0.32



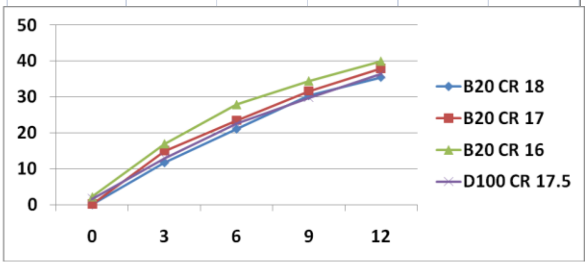
GRAPH.1 :LOAD VS SFC FOR B20 AND DIESEL AT CR 18 ,CR 17, CR 16 AND D100 CR 17.5

LOAD	0	3	6	9	12
B20 CR 18	0	0.9	1.7	2.6	3.5
B20 CR 17	0	1	1.7	2.5	3.4
B20 CR 16	0.1	1.1	1.9	2.7	3.5
D100 CR 17.5	0	0.6	1.2	1.7	2.3



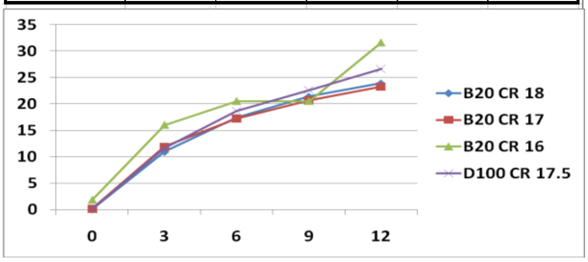
GRAPH.2: LOAD VS BP FOR B20 AND DIESEL AT CR 18 , CR 17, CR 16 AND D100 CR 17.5

LOAD	0	3	6	9	12
B20 CR 18	0	11.7	21.1	30.4	35.5
B20 CR 17	0.1	15	23.4	31.6	37.9
B20 CR 16	2.2	17	27.9	34.5	40
D100 CR 17.5	1.6	13	22.5	29.8	36.4



GRAPH.3 : LOAD VS ηmech(%) FOR B20 AND DIESEL AT CR 18 ,CR 17, CR 16 AND D100 CR 17.5

LOAD	0	3	6	9	12
B20 CR 18	0	10.9	17.4	21.4	23.9
B20 CR 17	0.1	11.9	17.2	20.7	23.3
B20 CR 16	1.8	16	20.5	20.5	31.6
D100 CR 17.5	0	11.6	18.6	22.6	26.6



GRAPH.4: LOAD VS ηbTh(%) FOR B20 AND DIESEL AT CR 18 , CR 17, CR 16 AND D100 CR 17.5

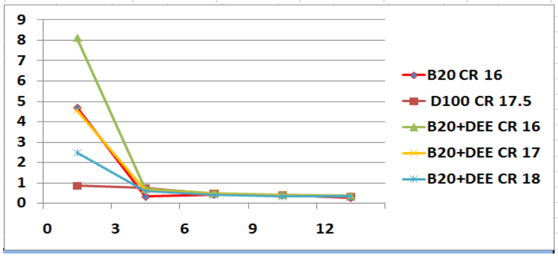
Results and Discussions-

Experiments were conducted on VCR Engine at constant speed by varying loads from 0 to 12 kg with Diesel with compression ratio 17.5:1 and B20 Biodiesel at compression ratios 16:1, 17:1 and 18:1. The performance parameters such as break power, mechanical efficiency, indicated thermal efficiency, break thermal efficiency, volumetric efficiency, Air fuel ration, Exhaust gas temperature, Indicated mean effective pressure, Break mean effective pressure and exhaust gas emissions like carbon monoxide, Hydro carbon, Carbon dioxide and Smoke density are taken from the system which was connected to the engine by using IC Engine analysis software as shown in graphs.

By comparing the above graphs between Blend B20 and D100 for the specific fuel consumption Blend B20 at half load condition at CR 18 is comparatively better and same as diesel. The Break power of an engine is more by using B20 as compared to D100. Mechanical efficiency and Thermal efficiencies are efficient in B20 at CR 18 at half load condition of an engine.

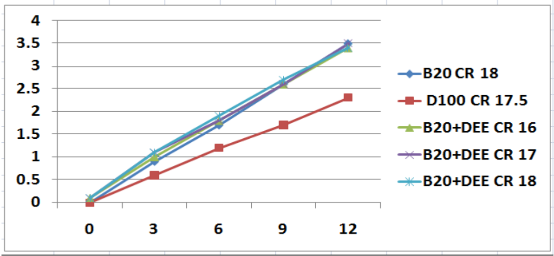
B. B20 at Best CR , D100 at CR 17.5 and B20+Additive DEE at Various Compression ratios

LOAD	0	3	6	9	12
B20 CR 16	4.7	0.33	0.42	0.42	0.27
D100 CR 17.5	0.86	0.74	0.46	0.38	0.32
B20+DEE CR 16	8.12	0.72	0.51	0.43	0.38
B20+DEE CR 17	4.56	0.65	0.47	0.4	0.35
B20+DEE CR 18	2.48	0.61	0.42	0.35	0.34



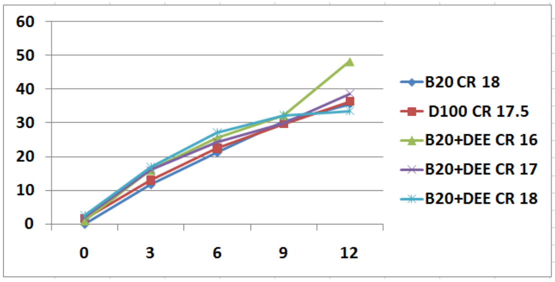
GRAPH.5: LOAD VS SFC for B20 ,D100, and B20+DEE

LOAD	0	3	6	9	12
B20 CR 18	0	0.9	1.7	2.6	3.5
D100 CR 17.5	0	0.6	1.2	1.7	2.3
B20+DEE CR 16	0.1	1	1.8	2.6	3.4
B20+DEE CR 17	0.1	1.1	1.8	2.6	3.5
B20+DEE CR 18	0.1	1.1	1.9	2.7	3.4



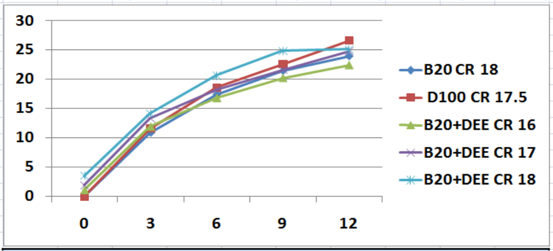
GRAPH.6: LOAD VS BP for B20 ,D100, and B20+DEE

LOAD	0	3	6	9	12
B20 CR 18	0	11.7	21.1	30.4	35.5
D100 CR 17.5	1.6	13	22.5	29.8	36.4
B20+DEE CR 16	1	16	25.5	32.2	48.2
B20+DEE CR 17	2	16	24.4	30	38.7
B20+DEE CR 18	2.6	16.8	27.1	32.1	33.5



GRAPH.7: LOAD VS η_{mech}(%) for B20 ,D100, and B20+DEE

LOAD	0	3	6	9	12
B20 CR 18	0	10.9	17.4	21.4	23.9
D100 CR 17.5	0	11.6	18.6	22.6	26.6
B20+DEE CR 16	1.1	11.9	16.8	20.2	22.4
B20+DEE CR 17	1.9	13.3	18.3	21.6	24.8
B20+DEE CR 18	3.5	14.1	20.6	24.8	25.1



GRAPH.8: LOAD VS η_{bTh}(%) for B20 ,D100, and B20+DEE

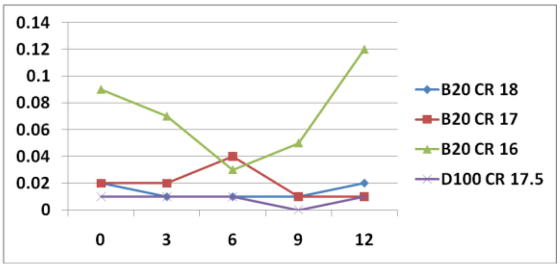
Results and Discussions-

From the above graphs the performance parameters has been observed for B20, D100 and B20 + Additive DEE (20%) at various compression ratios (CR 16, CR 17 and CR 18). Performance is carried out in the following ways. First B20 at best compression ratio, D100 at 17.5 and B20 + DEE are taken to know the better results. From this analysis we will know the better blend and better Compression Ratios to give less emissions and better performance of the engine.

From the Graph 1 SFC is lower at half load condition at compression ratio 18:1. At half load condition SFC values of B20 + DEE is slightly consuming lower fuel and all other fuel blends are consuming almost equal fuel. In Graph 2 Break Power is better in B20 and B20 + DEE at CR 18 as compared with D100. In Graph 3 and 4 B20 with DEE Additive with respective load at compression ration 18:1.got the better results in mechanical efficiency and Break thermal efficiencies.

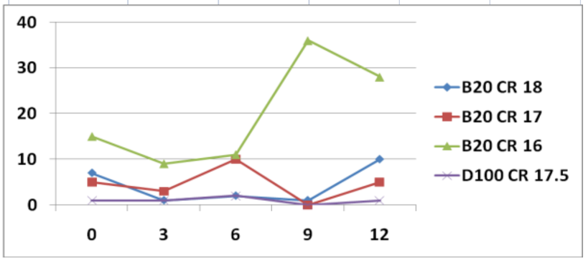
C. Emission And Smoke Parameters

LOAD	0	3	6	9	12
B20 CR 18	0.02	0.01	0.01	0.01	0.02
B20 CR 17	0.02	0.02	0.04	0.01	0.01
B20 CR 16	0.09	0.07	0.03	0.05	0.12
D100 CR 17.5	0.01	0.01	0.01	0	0.01



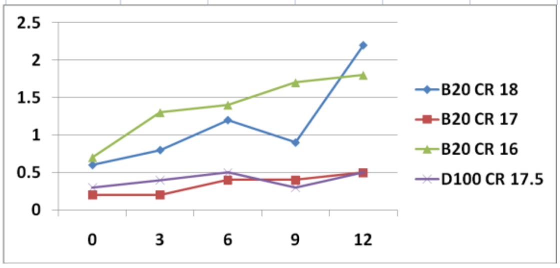
GRAPH.9: LOAD VS CO FOR B20 AND DIESEL AT CR 18 , CR 17, C 16 AND D100 CR 17.5

LOAD	0	3	6	9	12
B20 CR 18	7	1	2	1	10
B20 CR 17	5	3	10	0	5
B20 CR 16	15	9	11	36	28
D100 CR 17.5	1	1	2	0	1



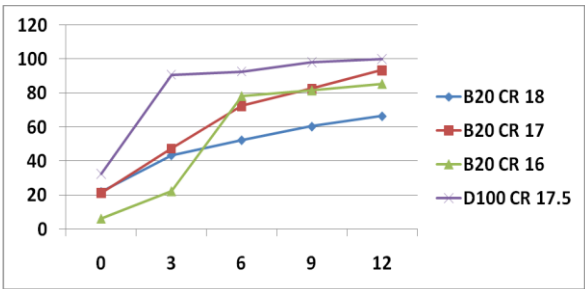
GRAPH.10: LOAD VS HC FOR B20 AND DIESEL AT CR 18 , CR 17, C 16 AND D100 CR 17.5

LOAD	0	3	6	9	12
B20 CR 18	0.6	0.8	1.2	0.9	2.2
B20 CR 17	0.2	0.2	0.4	0.4	0.5
B20 CR 16	0.7	1.3	1.4	1.7	1.8
D100 CR 17.5	0.3	0.4	0.5	0.3	0.5



GRAPH.11: LOAD VS CO_2 FOR B20 AND DIESEL AT CR 18, CR 17, CR 16 AND D100 CR 17.5

LOAD	0	3	6	9	12
B20 CR 18	22	43.5	52.4	60.4	66.5
B20 CR 17	21.4	47.5	72.4	82.6	93.5
B20 CR 16	6.2	22.3	78.2	81.5	85.4
D100 CR 17.5	32.5	90.8	92.6	98	100



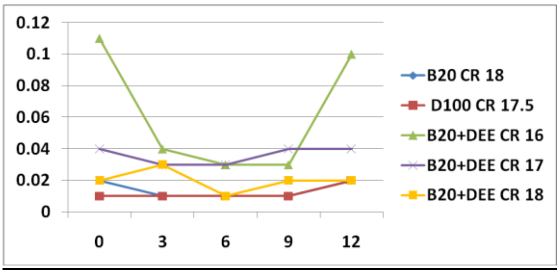
GRAPH.12: LOAD VS SMOKE DENSITY FOR B20 AND DIESEL AT CR 18 ,CR 17, CR 16 AND D100 CR 17.5

Discussions and Results-

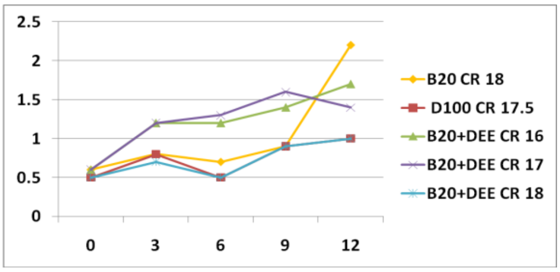
From the above graphs emission and smoke parameters CO, HC,CO_2 and Smoke density are different at different compression ratios.CO for B20 at CR 18 is lower as compared with D100. HC is almost equal in B20 at CR 18 and D100. $C0_2$ is observed lower in B20 at CR 17.

Smoke density is lower in all the cases for B20 as compared with D100.

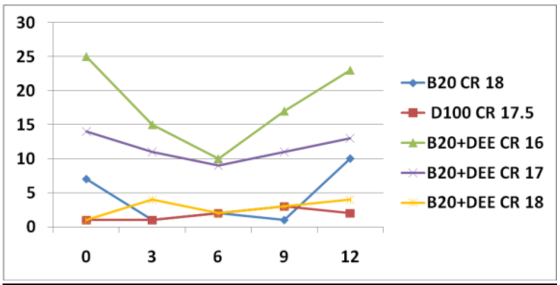
B20 at CR 18, D100 at CR 17.5 and B20+Additive DEE at Various Compression ratios for emissions and smoke density



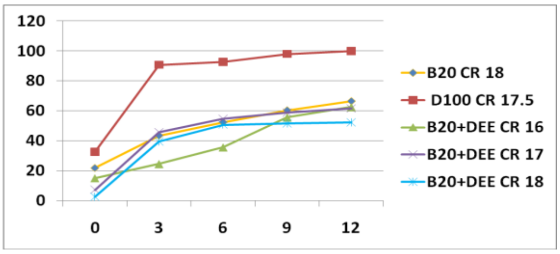
GRAPH.13: LOAD VS CO for B20 ,D100, and B20+DEE



GRAPH.14: LOAD VS CO_2 for B20 ,D100, and B20+DEE



GRAPH.15: LOAD VS HC for B20 ,D100, and B20+DEE



GRAPH.16: LOAD VS SMOKE DENSITY for B20 ,D100, and B20+DEE

Discussions and Results-

From the graphs shown above for emissions and smoke density are drastically changed by adding Diethyl Ether as an additive with lend B20. CO,HC and CO_2 are more in B20+DEE at CR 16, B20+DEE at CR 18 and D100 are comparatively giving equal emissions at half load condition. Smoke density of B20+DEE is drastically changed as compared with D100 as shown in above graph.

V. CONCLUSION

Comparing the experimental results of performance parameters and emission parameters with diesel(D100), blend B20 of palm oil biodiesel with additive Diethyl Ether(20%) will give the better results.

From the results it was observed that the emissions and Smoke density are drastically changed by using Bio diesel with additive DEE.

Compression Ratios of bio diesel at CR 16, CR 17, CR 18 has been tested and CR 18 is better in performance at half load condition than other compression ratios including D100 at CR 17.5.

REFERENCES

[1]. Amar Pandhare, ”Investigation on Performance and Emission characteristics of diesel engine with biodiesel (Jatropha Oil) and its blends” Journal of Renewable Energy, Volume 2013, Article ID 163829.

[2]. BijuCherian Abraham, “Performance characteristics of biodiesel mixtures in a variable compression ratio engine with CR 17” International Journal of Mechanical Engineering and Technology (IJMET) Volume 6, Issue 8, Aug 2015.

[3]. Ganesan, V., “Internal combustion engines”, Tata McGraw-Hill, New Delhi.

[4]. G.Pavan, M.Rajesh and K.Srinivas, “Performance and Exhaust Emissions Using Blends on VCR Diesel Engine with Varying Compression Ratio of Hibiscus Oil” International Journal of Engineering Trends and Technology (IJETT), Volume 17 Number 2, Nov 2014.

[5]. K. Tarun, G. Saignanakara, S. Abhinav, K. Saisatvik had conducted test on “Performace Characteristics of Neem Biodiesel” on IC engine. Volume 5, Issue 4, April (2014), 51-60.