EXPERIMENTAL INVESTIGATION ON SINGLE CYLINDER FOUR STROKE C.I ENGINE FUELED AS A PURIFIED ENGINE OIL

[1]K.Veeranjaneyulu [2]Dr.T.Venkateswara Rao

[1]Assistant Professor & Research Scholar in KLEF, Department Of Mechanical Engineering, Anurag Engineering College, Ananthagiri(V&M), Suryapet Dt, Telangana,India,
[2] Professor, Department Of Mechanical Engineering, DBS Institute Of Technology, Kavali, SPSR Nellore Dt, Andhra Pradesh,India

Abstract: The basic function of lubricating oil in machines is to minimize friction and wear in order to enhance their life span of machines. When lubricating oils have been used beyond their recommended life span, improper disposal can be harmful the environment. and also, Due to scarcity of diesel products, the used engine oils can be used in CI engine as fuel after purifying it. Production of diesel fuel from used engine oil is involved heat treatment, chemical filtration and find the properties of the final product of waste oil and compare with fresh diesel, To evaluate the performance of the engine .These purified oil use as fuel in ships, light vehicles, buses, trucks etc. and it reduces the economic loses, fuel cost, environmental pollution and disposal problems. Main advantage is reuse the waste engine oil as a fuel then there is a decrease the amount of fuel requirement so economically helpful.

I.INTRODUCTION:

In recent years, diminishing of fossil fuel sources, growing of demand and cost of petroleum-based fuels, and environmental hazards as a result of burning of them have encouraged researchers to investigate possibility of using alternative fuels instead of the fossil fuels. Therefore, the researchers have focused on finding alternative new energy resources and utilizing them. They have stated that it is necessary to reduce consumption of the petro fuels due to the negative effects on human life by producing alternative renewable fuels. As known fossil energy sources have been exhausted rapidly nowadays, it is predicted that fossil fuel sources will be depleted in the near. According to some studies, it is estimated that crude oil will last only for roughly 80 more years, gaseous fuels for about 150 years, and coal for 230 years. Therefore, scientists and researchers all over the world are now working hard to discover new sources of energy for the future, and also try to develop new technologies that allow recycling or reusing waste material as a source of energy. Many research works addressed the utilization of waste oils that are of lubricating oils originated from crude oil and biomass origin waste oils for the case of diesel engine applications as sources of energy. The gaseous yield from steam gasification and pyrolysis of biomass have been investigated experimentally, the results of steam gasifi cation have been compared to that of pyrolysis. The temperature range investigated at elevated temperature in the range of 550–1000 C. Hydrogen is produced from steam gasification and pyrolysis at the elevated temperatures. Mineral waste lubricating oil sources, particularly engine oils have attracted much attention as an alternative energy source. It is renewable, available everywhere and proved to be cleaner fuel and more environment friendly than fossil sources. The lubricating oils can be recycled as lubricating oil, and re-used as fuel or made into diesel-like fuel. Production of diesel-like fuel from waste oils such as industrial and engine waste oils, wood pyrolysis oils, fresh and waste fats and vegetable oils is an excellent way for producing alternative fuel sources. Industrial and engine waste oils, wood pyrolysis oils, fresh and waste fats and vegetable oils have been proposed as pyrolysis raw material to produce gasoline and diesel-like fuels. There is plenty of the waste engine oil in the world. Abundant amounts of used engine lubricating oils are produced worldwide every year. Annually, about 40 million metric tones are produced, and around 60% of the production becomes waste. Less than 45% of available waste oil was collected worldwide in 1995, and the remaining 55% was either misused or discarded by the end user in the environment . It should be collected and re-used in order to decrease detrimental effects on environment, and underground and surface waters, since it pollutes the atmospheric air as a result of burning, and has negative effects on living organisms, underground and surface waters when it is discharged into soil or water.

Conversion of the waste engine oils into diesel like fuel by using pyrolytic distillation, and by utilization of the product as a diesel fuel has positive effects on environment and atmospheric air, and also has economical value. Recently, recycling and utilizing of waste oils have received significant attention all over the world, since waste lubricant oils are considered toxic and hazardous because of the presence of metal particles remaining from the additives such as phenols, compounds of zinc, chlorine and phosphorus, chlorinated compounds, polycyclic aromatic hydrocarbons and other residues. Waste materials of petroleum are exposed to various processes and then used as fuel or they are converted into various chemicals in order to minimize the harmful effects of these wastes. However, materials, such as sulfur, nitrogen chlorine and bromine found in waste oils are the most important factors making it difficult to recycle waste oils for various purposes including the production of fuel. The sulphur found in waste oils precipitates by undergoing a chemical reaction with metal oxide powders, such as zinc oxide, iron oxide and copper oxide in a certain temperature, so sulfuric acid can be decomposed from the oil. Waste oils can be reconstructed chemically by being heated in an oxygen-free environment. The most important advantage of this method is that it does not pollute the environment when carried out in an appropriate way. In this study, waste lubrication engine oil samples were purified from contaminants, and the clean oil samples were blended with additives of sodium carbonate, lime and zeolite. The oil samples with the additives were heated in the reactor and exposed to pyrolytic distillation separately. They were exposed to thermal and pyrolytic treatment in order to convert them into a diesel-like fuel during the heating process. After that process, typical characteristics of the fuel, such as density, viscosity, flash and fire point, sulphur content, heating value and distillation temperatures were tested. Effects of the additives on these characteristics were discussed. Also it was discussed whether the obtained fuel would be used in a diesel engine or not.

II.EXPERIMENTAL SETUP:

Distillation Reactor: The reactor is the most important part of the recycling system, since pyrolytic distillation or thermal treatment of the waste oil is performed in the reactor. It has a cylindrical shape with dimensions of 5 m in diameter and 20 m in height.It has a capacity that will be able to produce 10000 L of fuel. This volume is enough to do all tests, which include characteristics of the fuel, performance and emissions. The reactor was isolated with glass wool with a thickness of 10 cm to minimize heat loss from the reactor.Therefore, it was taken from the tank by the oil pump, and was flowed through the filters having 20 µm mesh sizes. It was separated from dust, carbon soot, metal and other particles, and then charged to the reactor. The oil was heated up to 330°C in the reactor, in which the pyrolysis process occurred, and it was treated for 1 h at this temperature. During the process, the mixer in the reactor mixed the oil-additive mixture. Heating process was continued by increasing the reactor temperature with electronic control unit in order to pass to the distillation process after the pyrolysis process.

Fig 1 Distillation reactor

Condenser: Condenser is the second important component in the recycling system. The length of the condenser-1 is 3 m and diameter is of 0.5 mtrs . The working of condenser-1 is condense the vapour source from the reactor. First condense the water up to 100 °C- 150 °C . Then after above the 150 °C oil vapour will be condensed and collected at storage tank 1. The uncondensed vapour is passed from the second condenser. Here the condensed vapour will be condensed by the help of water . These content is collected in storage tank-2.

Condenser-1 **Condenser-1**

Storage Tank : The collected content from condenser-1 is stored in storage tank -1. It has a cylindrical shape with dimensions of 3 m in diameter and 5 m Length. Condensed water is drained from this tank before storing of oil the and also it sends the distilled oil to catalytic tank . The collected content from condenser-2 is stored in storage tank -2. It has a cylindrical shape with dimensions of 3 m in diameter and 5 m Length. It sends the uncondensed gases to the water seal device and also it sends the distilled oil to catalytic tank.

Storage tank-1

Storage tank -2

Water Seal Device: Water seal device is also called as uncondensed gases storage tank. It is in closed cylindrical shape having a length 1.5 mtrs and diameter is 1 mtr. It contains water half of the level on tank. One pipe is connected from the storage tank-2 to bottom of the water, the uncondensed gases are collected on this tank and odour will observed by the water and gases will be pass out from chimney and used also as fuel on burning chamber.

Water seal device

Catalytic Tank: Catalytic tanks are mixing devices, here we are using three catalytic tanks each one tank having one stirrer connected with electric motor. Tank 1 is used for sulphuric acid mixing, tank 2 is used for NaOH mixing, tank 3 is used for activated clay mixing.

Catalytic tank

Filter Press: Filter press is used for filter the liquid from released from activated clay catalytic tank. These filter press having 20-30 filter plater, filter size is 3 microns.

Filter Press

Vaccum System : Vaccum pump is connected with catalytic tank 3 the clay mixed liquid is having some quality of water, It will be evaporate by internal heat apply and these vapour removed by the help of these vaccum pump.

Thermic Fluid Tank: Thermic fluid tank also called as conduction oil tank . It is having conduction oil it means heat exchanging oil, these oil is used for internal excess heat gives to the distillation reactor and catalytic tank 3. In distillation reactor it spreads the heat to the total amount of oil.

Thermic fluid tank

Boiler: Boiler is used for heating of thermicfluid by the help of external heating with fire oil burner. It sends the thermic fluid to the distillation reactor and catalytic tank 3.

Boiler

Buffer Tank: It stores the thermic fluid comes from the outlet of the reactor and catalytic tank and conduction oil tank and it sends also conduction oil to the conduction oil tank.

Dedusting System:

Dedusting System

Draft Fan: Induced draft fan is always located between dust collector and chimney. ID fan will take the hot flue gasses from furnace via dust collector (dust separation system) and will deliver to chimney.ID fan will produce the pressure lower than the atmospheric pressure lower than the atmospheric pressure in the system or we may say that ID fan will produce the negative pressure in the furnace to remove the flue gases from furnace via electro static precipitators and to push the flue gases to chimney.

Draft Fan

Chimney: A chimney is a structure that provides ventilation for hot flue gases or smoke from a boiler , Furnace or fire place to the outside atmosphere.

Burner: Burner is used to generate the heat on heating chamber by using tyre oil as a fuel to increasing the temperature of waster oil.

Burner

Control Panel : It controls the temperature of the distillation reactor.

Control panel

Engine Setup:

Kirloskar TV1 I.C Engine.

SPECIFICATIONS OF I.C ENGINE

SR.NO.		
1	Model	KIRLOSKAR, AV1 - 5 hp @ 1500 rpm
2	Method of starting	Hand starting
3	Type ,No. of cylinders	Vertical- 4-stroke, 1 cylinder
4	Specific fuel consumption	245 g/kWh or (180 g/bhp-hr)
5	Cylinder data	Bore 80 mm **X** stroke length 110 mm
6	Power output with speed	3KW or 5 HP at 1500 rpm
7	Lubrication oil consumption	1% of maxi. specific fuel consumpsion
8	Cubic Capacity	0.553 lit
9	Nominal power	3 Hp
10	Compression Ratio	16.5 : 1
11	Sump oil capacity	4 liter
12	Cooling system	Water-cooled
13	Rotation	Clockwise. Optional - Anticlockwise
14	Fuel filter	Present

III.Results & Discussions:

S.No	Load in kg		Speed in rpm	Time taken for 10cc fuel in sec	Manometer difference			Spring Balance (w2-w1)
	W1	W2			h1	h2	(h2-h1)	
1	0	0	1500	68	5	10	5	0
2	1	2	1500	68	5	10	5	1
3	1	4	1500	56	10	15	5	3
4	1	6	1500	48	10	20	10	5
5	1	8	1500	44	10	25	15	7

Performance test on I.C engine with Diesel

3.1Break Power :

$$Bp = \frac{2\prod NT}{60 \times 1000} \text{ KW}$$

T= (W2-W1) × r × g

N= RPM of the engine

W1= Load on the right side dial

W2= Load on the side dial

$r = \frac{D+d}{2} = 0.16$ m, radius of brake drum in meter

g= gravity = 9.81

AT 2 KGS LOAD :

$$Bp = \frac{2\times\prod\times1500\times1.56}{60 \times1000} \text{ KW}$$

Bp = 0.24 Kw

AT 4 KGS LOAD :

$Bp = \frac{2\times\prod\times1500\times4.70}{60\times1000}$ KW

Bp = 0.73 Kw

AT 6 KGS LOAD :

$Bp = \frac{2\times\prod\times1500\times7.8}{60\times1000}$ KW

Bp = 1.22 Kw

AT 8 KGS LOAD :

$Bp = \frac{2\times\prod\times1500\times10.98}{60\times1000}$ KW

Bp = 1.72 Kw

3.2 Mass Fuel Consumption :

$Mfc = \frac{x\times0.82\times3600}{T\times1000}$ Kg/hr.

X= Burette reading in cc (10 cc)

0.82= Density of diesel in gram/cc

T= Time taken in seconds.

AT 2 KGS LOAD :

$Mfc = \frac{10\times0.82\times3600}{68\times1000}$ Kg/hr.

Mfc = 0.43 Kg/hr.

AT 4 KGS LOAD :

$Mfc = \frac{10\times0.82\times3600}{56\times1000}$ Kg/hr.

Mfc = 0.52 Kg/hr.

AT 6 KGS LOAD :

$Mfc = \frac{10\times0.82\times3600}{48\times1000}$ Kg/hr.

Mfc = 0.615 Kg/hr.

AT 8 KGS LOAD :

$Mfc = \frac{10\times0.82\times3600}{44\times1000}$ Kg/hr.

Mfc = 0.67 Kg/hr.

3.3 Specific Fuel Consumption :

$SFC = \frac{mfc}{BP}$ Kg/ Kw.hr

AT 2 KGS LOAD :

$SFC = \frac{0.43}{0.24}$ Kg/ Kw.hr

SFC = 1.808 Kg/ Kw.hr

AT 4 KGS LOAD :

$SFC = \frac{0.52}{0.73}$ Kg/ Kw.hr

SFC = 0.712 Kg/ Kw.hr

AT 6 KGS LOAD :

$SFC = \frac{0.615}{1.22}$ Kg/ Kw.hr

SFC = 0.498 Kg/ Kw.hr

AT 8 KGS LOAD :

$SFC = \frac{0.67}{1.72}$ Kg/ Kw.hr

SFC = 0.388 Kg/ Kw.hr

3.4 Actual volume of air sucked into the cylinder :

$V_A = C_d \times A\ \sqrt{2gh} \times 3600$ m³/hr.

$H = \frac{h}{100} \times \frac{\rho w}{\rho a}$ Meter of water

h = Manometer difference(h2-h1) in m

ρw = Density of water

ρw = Density of air = 1.8

A= Area of orifice = $\frac{\prod d^2}{4}$, d = 20 mm

Cd = Coefficient of discharge = 0.62

g = gravity = 9.81

AT 2 KG LOAD :

$H = \frac{5}{1000} \times \frac{1000}{1.8} = 2.7$

$V_A = 0.62 \times (3.14/1000)\ \sqrt{2*9.8*2.7} \times 3600$ m³/hr.

= 5.10 m³/hr.

AT 4 KG LOAD :

$H = \frac{5}{1000} \times \frac{1000}{1.8} = 2.7$

$V_A = 0.62 \times (3.14/1000)\ \sqrt{2*9.8*2.7} \times 3600$ m³/hr.

= 5.10 m³/hr.

AT 6 KG LOAD :

H = 5.5

$V_A = 7.280$ m³/hr.

AT 8 KG LOAD :

H = 8.33

$V_A = 8.95$ m³/hr.

3.5 **Swept Volume :**

$V_S = \frac{\prod d^2}{4} \times L \times \frac{N}{2} \times 60$

d = dia of bore = 80 mm =0.08 m

L = Length of stroke

N = Speed of the engine rpm.

AT 2 KG LOAD :

$V_S = 24.88$

At 4 kg load $V_S = 24.88$

At 6 kg load $V_S = 24.88$

At 8 kg load $V_S = 24.88$

3.6 Volumetric Efficiency

$\dot{\eta} = \frac{VA}{VS} \times 100$

AT 2 KG LOAD $\dot{\eta}$ = 20.49 %

AT 4 KG LOAD $\dot{\eta}$ =20.49 %

AT 6 KG LOAD $\dot{\eta}$ = 30.26 %

AT 8 KG LOAD $\dot{\eta}$ =38.77 %

3.7 Break Thermal Tfficiency

$\dot{\eta} = \frac{Bp*3600*100}{mfc*Cv}$

Cv = Calorific value od diesel = 42500 KJ/Kg

Bp = Break power in KW

AT 2 Kg OF LOAD :

$\dot{\eta} = \frac{0.24*3600*100}{0.43*42500} = 4.72$

AT 4 KG LOAD $\dot{\eta}$ = 11.89 %

AT 6 KG LOAD $\dot{\eta}$ = 16.94 %

AT 8 KG LOAD $\dot{\eta}$ = 21.74 %

Avg volume efficiency = 27.55%
Avg break thermal = 14.82 %

3.8 PERFORMANCE TEST ON I.C ENGINE WITH DIESEL LIKE FUEL

S.No	Load in kg W1	W2	Speed in rpm	Time taken for 10cc fuel in sec	Ma h1	h2
1	0	0	1500	68	5	
2	1	2	1500	68	5	10
3	1	4	1500	55	10	15
4	1	6	1500	46	10	
5	1	8	1500	42	10	25

Performance Test On I.C Engine With Diesel Like Fuel

3.8.1 BREAK POWER :

Bp = $\frac{2\prod NT}{60 \times 1000}$ KW
T= (W2-W1) × r × g
N= RPM of the engine
W1= Load on the right side dial
W2= Load on the side dial
r = $\frac{D+d}{2}$ = 0.16 m, radius of brake drum in meter
g= gravity = 9.81

<u>AT 2 KGS LOAD :</u>
Bp = $\frac{2\times\prod\times1500\times1.56}{60 \times 1000}$ KW
Bp = 0.24 Kw

<u>AT 4 KGS LOAD :</u>
Bp = $\frac{2\times\prod\times1500\times4.70}{60 \times 1000}$ KW
Bp = 0.738 Kw

<u>AT 6 KGS LOAD :</u>
T = 7.84 N.M
Bp = 1.231 Kw

<u>AT 8 KGS LOAD :</u>

Bp = $\frac{2\times\prod\times1500\times10.98}{60 \times 1000}$ KW
Bp = 1.72 Kw

3.8.2 MASS FUEL CONSUMPTION :

Mfc = $\frac{x\times0.82\times3600}{T \times 1000}$ Kg/hr.
X= Burette reading in cc (10 cc)
0.82= Density of diesel in gram/cc
T= Time taken in seconds.

<u>AT 2 KGS LOAD :</u>

Mfc = $\frac{10\times0.84\times3600}{66 \times 1000}$ Kg/hr.
Mfc = 0.458 Kg/hr.

<u>AT 4 KGS LOAD :</u>

Mfc = $\frac{10\times0.84\times3600}{55 \times 1000}$ Kg/hr.
Mfc = 0.54 Kg/hr.

<u>AT 6 KGS LOAD :</u>
Mfc = $\frac{10\times0.84\times3600}{46 \times 1000}$ Kg/hr.
Mfc = 0.65 Kg/hr.

<u>AT 8 KGS LOAD :</u>

Mfc = $\frac{10\times0.84\times3600}{42 \times 1000}$ Kg/hr.
Mfc = 0.72 Kg/hr.

3.8.3 SPECIFIC FUEL CONSUMPTION :

SFC = $\frac{mfc}{BP}$ Kg/ Kw.hr

<u>AT 2 KGS LOAD :</u>
SFC = $\frac{0.45}{0.24}$ Kg/ Kw.hr
SFC = 1.90 Kg/ Kw.hr

<u>AT 4 KGS LOAD :</u>
SFC = $\frac{0.54}{0.758}$ Kg/ Kw.hr
SFC = 0.731 Kg/ Kw.hr

<u>AT 6 KGS LOAD :</u>
SFC = $\frac{0.657}{1.23}$ Kg/ Kw.hr
SFC = 0.533 Kg/ Kw.hr

<u>AT 8 KGS LOAD :</u>
SFC = $\frac{0.72}{1.72}$ Kg/ Kw.hr
SFC = 0.418 Kg/ Kw.hr

3.8.4 ACTUAL VOLUME OF AIR SUCKED INTO THE CYLINDER :

$V_A = C_d \times A \sqrt{2gh} \times 3600$ m³/hr.
H = $\frac{h}{100} \times \frac{\rho w}{\rho a}$ Meter of water
h = Manometer difference(h2-h1) in m
ρw = Density of water
ρw = Density of air = 1.8
A= Area of orifice = $\frac{\prod d^2}{4}$, d = 20 mm
Cd = Coefficient of discharge = 0.62
g = gravity = 9.81

<u>AT 2 KG LOAD :</u>

H = $\frac{5}{1000} \times \frac{1000}{1.8}$ = 2.7
$V_A = 0.62 \times (3.14/1000)\sqrt{2 * 9.8 * 2.7} \times 3600$ m³/hr.
= 5.10 m³/hr.

<u>AT 4 KG LOAD :</u>
H = $\frac{5}{1000} \times \frac{1000}{1.8}$ = 2.7
$V_A = 0.62 \times (3.14/1000)\sqrt{2 * 9.8 * 2.7} \times 3600$ m³/hr.
= 5.10 m³/hr.

<u>AT 6 KG LOAD :</u>
H = 5.5
V_A = 7.30 m³/hr.

<u>AT 8 KG LOAD :</u>

H = 8.33
V_A = 8.99 m³/hr.

3.8.5 SWEPT VOLUME :

$V_S = \frac{\prod d^2}{4} \times L \times \frac{N}{2} \times 60$
d = dia of bore = 80 mm =0.08 m
L = Length of stroke
N = Speed of the engine rpm.

<u>AT 2 KG LOAD :</u>
V_S = 24.88
At 4 kg load V_S = 24.88
At 6 kg load V_S = 24.88
At 8 kg load V_S = 24.88

3.8.6 VOLUMETRIC EFFICIENCY

$\dot{\eta} = \frac{VA}{VS} \times 100$

AT 2 KG LOAD $\dot{\eta}$ = 20.49 %
AT 4 KG LOAD $\dot{\eta}$ =20.49 %
AT 6 KG LOAD $\dot{\eta}$ = 29.26 %
AT 8 KG LOAD $\dot{\eta}$ =35.97 %

3.8.7 BREAK THERMAL EFFICIENCY

$\dot{\eta} = \frac{Bp*3600*100}{mfc*Cv}$

Cv = Calorific value od diesel = 42500 KJ/Kg
Bp = Break power in KW

<u>AT 2 Kg OF LOAD :</u>

$\dot{\eta} = \frac{0.24*3600*100}{0.458*42500} = 4.43$

AT 4 KG LOAD $\dot{\eta}$ = 11.57 %
AT 6 KG LOAD $\dot{\eta}$ = 15.85 %
AT 8 KG LOAD $\dot{\eta}$ = 20.23 %
Avg volume efficiency = 24.19%
Avg break thermal = 13.02%

COMPARISON OF PERFORMANCE OF DLF AND DIESEL :

S. NO	PERFORMANCE CHARACTERSTICS	DIESEL				DIESEL LIKE FUEL			
		2KG	4KG	6KG	8KG	2KG	4KG	6KG	8KG
1	Break Power (kw)	0.24	0.73	1.23	1.72	0.24	0.738	1.231	1.72
2	Mass fuel Consumption (kg/hr.)	0.43	0.52	0.61	0.67	0.458	0.54	0.65	0.72
3	SFC (kg/kw.hr)	1.80	0.71	0.49	0.388	1.90	0.731	0.533	0.418
4	Actual volume (m^3/hr)	5.10	5.10	7.280	8.95	5.10	5.10	7.30	8.999
5	Swept Volume (Vs)	24.88	24.88	24.88	24.88	24.88	24.88	24.88	24.88
6	Volumetric efficiency $\dot{\eta}$	20.49	20.49	30.26	38.97	20.49	20.49	30.26	35.97
7	Break thermal efficiency $\dot{\eta}$	4.72	11.89	16.94	21.74	4.43	11.57	16.94	20.23

Advantages and Disadvantages of DLF:

Advantages :

1) Easy to use, no vehicle modification or any fuelling equipment needed.
2) Power , Performance and economy proven power generation, Performance and cost made diesel like fuel a useful fuel.
3) Diesel like fuel is helps in reducing pollution by lowering waste oil disposals.
4) DLF is safer to handle and store in any place.
5) Lower cost than the general diesel.
6) Technically suitable for C.I engine.
7) Large range of waste oils can be recycled and reused.

Disadvantages :

1) Contains 1-3% sulphur compare with general diesel.
2) During purification process more chemicals are involved. So more care and attention is needed.
3) Bad odours occurs during purification process.
4) To complete each batch process it takes 24 hours.

IV.CONCLUSSION :A Successful used in oil purification process is imperative in view of the increasing demands of DLF and saving of general diesel products to power industrial machines and internal combustion engines. Purification of waste engine oil could result in both environmental and economical benefits. Fuel obtain from waste engines without any problems in terms od engine performance. The thermal and physical characteristics of the diesel like fuel are close to those values of a typical diesel sample. Economic benefits from used oil purifying in terms of reduction of imported diesel and petroleum products, conservation of oil resource, employment generation, provide eco-friendly disposal hazardous waste and revenue generation.

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