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Optimization of C.I Engine Parameters Using Artificial Neural

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Abstract - Optimization of Compression Ignition Engines through advanced artificial neural network is the modern process in mechanization and best utilization of modern technology for better economic scenarios in coming generation. This project deals with the feasibility of using artificial neural networks in combination with genetic algorithms to optimize the diesel engine settings. The engine is operated by using diesel and sunflower oil blends and the output parameters are calculated theoretically with the standard mechanical formulae and those manual experimental calculated values are used for training several neural networks with different various hidden layer [n x m] matrix combinations. The output values given by these trained networks are compared with experimental values and out of which the trained error values are taken for all networks.

Keywords : *Diesel engine, Sunflower oil, Artificial Neural Networks (ANNs), Back Propagation Algorithm, Matlab.*

I. INTRODUCTION

In this modern world of industries and technology the diesel engine plays a major role in various fields. It may be transportation (or) production e.t.c., with the increase of various applications to the diesel resources effects on the environment leading to effect like green house. Higher fuel efficiency in the diesel engine is achieved due to the high compression ratios along with relatively high oxygen concentration I the combustion chamber. However, these same factors results in high emission in diesel engine. The stringent emission norms have been an important driving force to develop the internal combustion engines more environment friendly. The main pollutants from diesel engines are Carbon Monoxide and Hydro Carbons

This recommends the intensive studies on the use of alternative fuels especially renewable ones like vegetable oils and alcohol’s. The use of vegetable oils as an alternative fuel for diesel engine is not a new concept. Infact early engines were demonstrated with vegetable oil. In a developing country like India where mass transportation plays an important role, the suitability of alternate fuels for a diesel fuel engine application has to be thoroughly investigated. Vegetable oils plays a prominent role in substituting diesel, since they are renewable and are easily produced in rural areas.

The efficiency of the non optimized injection system can be compensated by hotter combustion chamber which assists (vegetable oils) spray atomization. Hence the vegetable oil operation of the conventional engines is more efficient with low emissions compared with vegetable oil operation of the conventional engines. Because of the oxygen content of the vegetable oils, CO emissions are similar to the diesel operation or even lower in some oils. The smoke and un-burned fuel emission levels depend on the fuel spray. Characteristics and hence the conventional engine configuration reduces them to a greater extent.

Ultimately the disadvantages of vegetable oils, which are the causes for poor performance and heavy smoke, can be overcome by the use of vegetable oils in the conventional engine since the gas temperatures are higher. Hence in the resent work SUNFLOWER OIL has been tested as fuel in the conventional engine.

III. ARTIFICIAL NEURAL NETWORKS

An artificial neural network (ANN), usually called neural network (NN), is a mathematical model or computational model that is inspired by the structure and/or functional aspects of biological neural networks. A neural network consists of an interconnected group of artificial neurons, and it processes information using a connectionist approach to computation. In most cases an ANN is an adaptive system that changes its structure based on external or internal information that flows through the network during the learning phase. Modern neural networks are non-linear statistical data modelling tools. They are usually used to model complex relationships between inputs and outputs or to find patterns in data.

The relationship between the various inputs and output parameters can be easily brought about by optimization. The uses of neural network for engine predictions make it possible to perform optimization studies over the entire operating conditions. The optimized output is obtained by using Backward Feed Propagation method in Artificial Neural Network. The optimized output is obtained by using Artificial Neural Network with MATLAB software.

III. EXPERIMENTAL INVESTIGATION

The experiments were conducted by considering various parameters. The tests were conducted for Sunflower biodiesel with Diesel at different proportions (10%, 20%, 30% and 40%) for conventional engine. The tests were conducted from no load to maximum load conditions. The readings such as time taken to consume 20cc of fuel consumption, speed of the engine, temperatures, etc, were noted. The observations were recorded in tabular column and calculations are made using appropriate equations.

The experiments were conducted on a single cylinder Alamgir four stroke diesel engine. The general specifications of the engine are given in Table-1. By taking the engine performance and plot the graphs “Alamgir” engines for generating sets are fuel efficient, with the lube oil consumption less than 1% of S.C.F. lowest among the comparable brands. They are equipped with heavy flywheels incorporating 4% governing on the fuel injection equipment. This complete avoids voltage functions. In case of emergency, the unique overload stop feature safeguards equipments by shutting down the engine automatically

Table-1. Engine specifications.

Item	**Specifications**
Engine power	6.6 kW
Cylinder bore	102 mm
Stroke length	110 mm
Connecting Rod Length	234 mm
Engine speed	1500 rpm
Compression ratio	17.5

Table 2: Properties of Diesel and Sunflower biodiesel

Properties	Diesel	Sunflower Biodiesel
Calorific Value (kJ/kg)	43000	48500
Density (kg/m^3)	830	860.4
Flash point (°C)	40	232
Fire point (°C)	42	238

Fig 1:- Alamgir engine

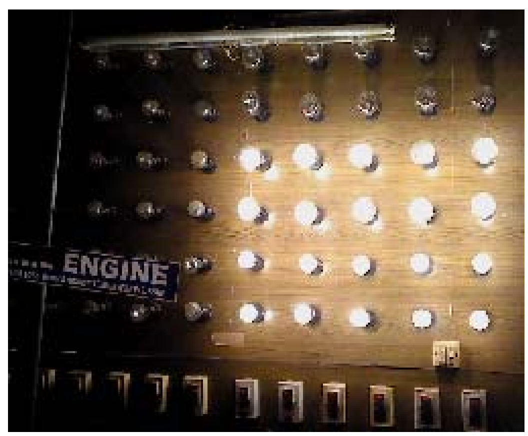


Fig 2:- Load indicator

IV. WORKING WITH MATLAB

MATLAB is a high performance language for technical computing. It integrates computation, visualization, and programming in an easy –to-use environment where problems and solutions are expressed in familiar mathematical notation.

4.1 FEEDING INPUTS AND OUTPUTS IN MATLAB

Initially the values are initialized in scaling form between 0 and 1 for getting trained output value. If it is not scaled error will be greater and all these scaled values are entered in command window as

Speed = [.1500 .1500 .1500 .1500 .1500 .1500]

Voltage = [.270 .260 .250 .230 .215 .200]

Input = [Speed; Voltage]

Bp = [.0765 .153 .240 .312 .377 .408]

Tfc = [.076 .105 .13 .153 .174 .191]

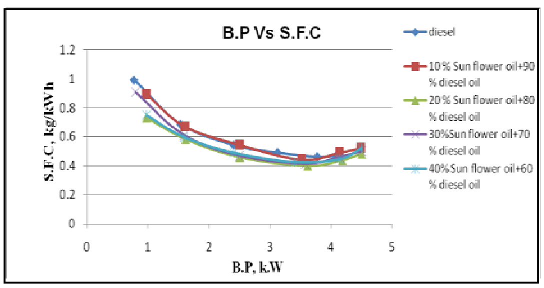
The output should be initialised in same manner as input was initialised but one difference is it should be initialised according to the neurons that the user preferred.

For e.g., if the user prefers 2 neurons, then the output should be assigned as

Output1= [Bp; Tfc]

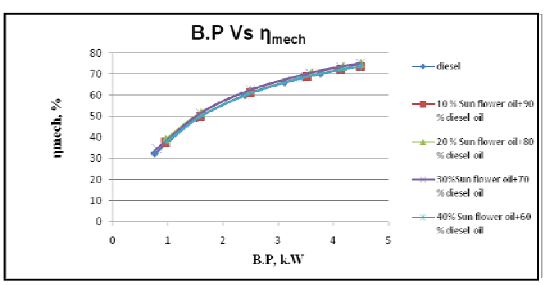
V. RESULTS AND DISCUSSIONS

For experimental values



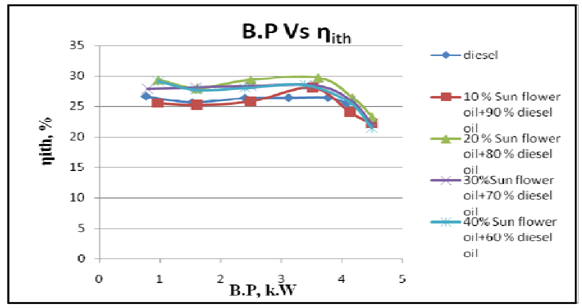
Graph 1: Brake Power Vs Specific Fuel Consumption

In the above graph 1specific fuel consumption of the blends has been compared with diesel fuel at various loads and it is shown in graph. It is observed that the BSFC for B20 blend was considering lower than the diesel and other blends operation over entire load range.



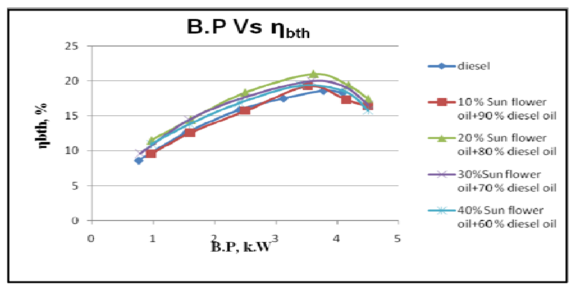
Graph No 2: Brake Power Vs Mechanical Efficiency

In the above graph 2 the Mechanical Efficiency of the blends has been compared with diesel fuel at various loads and it is shown in graph. It is observed that the Mechanical Efficiency for B20 blend was higher than the diesel and other blends operation over entire load range.



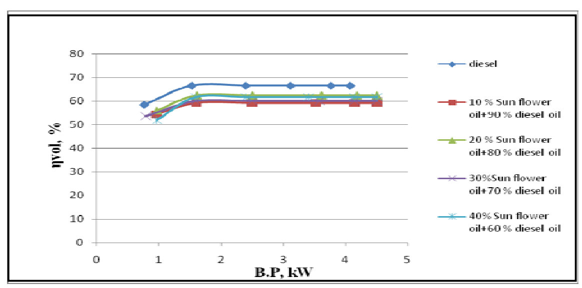
Graph No 3: Brake Power Vs Indicated Thermal Efficiency

In the above graph 3 Indicated Thermal Efficiency of the blends has been compared with diesel fuel at various loads and it is shown in graph. It is observed that the Indicated Thermal Efficiency for B20 blend was higher than the diesel and other blends operation over entire load range.



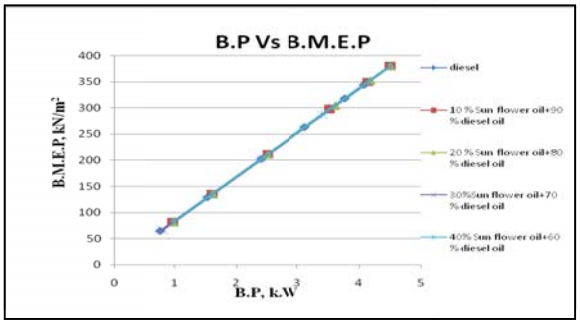
Graph No 4: Brake Power Vs Brake Thermal Efficiency

In the above graph 4 Brake Thermal Efficiency of the blends has been compared with diesel fuel at various loads and it is shown in graph. It is observed that the Brake thermal Efficiency for B20 blend was higher than the diesel and other blends operation over entire load range.



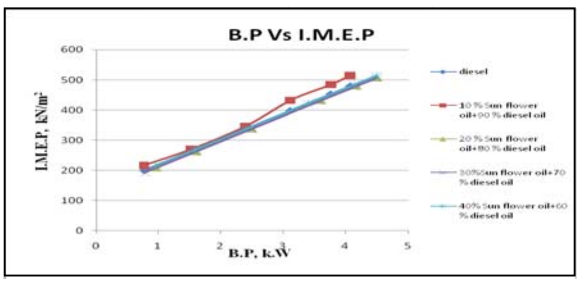
Graph No 5: Brake Power Vs Volumetric Efficiency

In the above graph 5 Volumetric Efficiency of the blends has been compared with diesel fuel at various loads and it is shown in graph. It is observed that the Volumetric Efficiency for diesel is higher than other blends operation over entire load range.



Graph No 6: Brake Power Vs BMEP

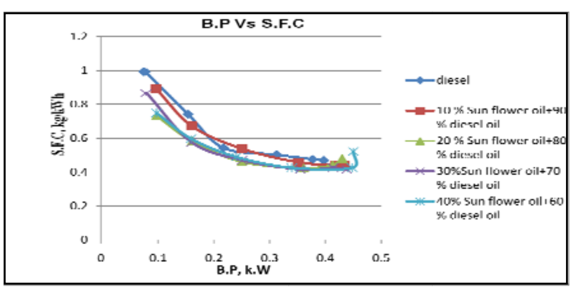
In the above graph 6 BMEP of the blends has been compared with diesel fuel at various loads and it is shown in graph. It is observed that the BMEP for B20 is higher than other blends operation over entire load range.



Graph No 7: Brake Power Vs IMEP

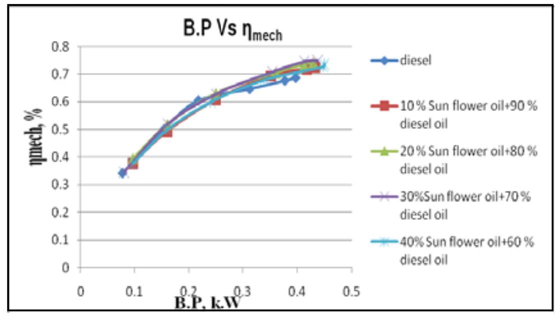
In the above graph 7 IMEP of the blends has been compared with diesel fuel at various loads and it is shown in graph. It is observed that the IMEP for B10 is higher than other blends operation over entire load range.

For Trained Values



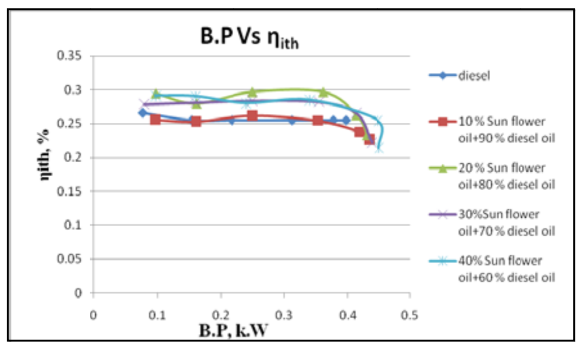
Graph 8: Brake Power Vs Specific Fuel Consumption

In the above graph 8 specific fuel consumption of the blends has been compared with diesel fuel at various loads and it is shown in graph. It is observed that the BSFC for B20blend was considering lower for first four loads and for remaining loads B30 is lower over the diesel and other blends operation over entire load range.



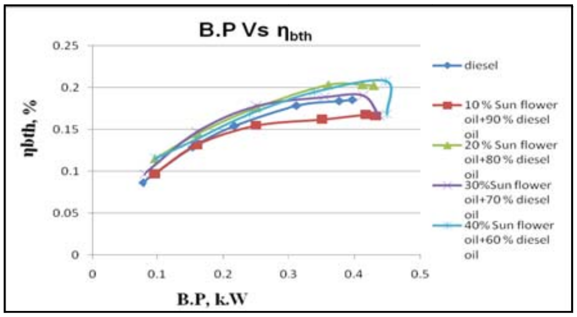
Graph 9: Brake Power Vs Mechanical Efficiency

In the above graph 9 Mechanical efficiency of the blends has been compared with diesel fuel at various loads and it is shown in graph. It is observed that the Mechanical Efficiency for B20blend was considering Higher for first three loads and for remaining loads B30 is higher over the diesel and other blends operation over entire load range.



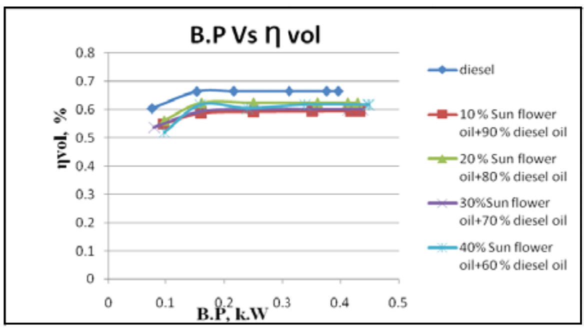
Graph 10: Brake Power Vs Indicated Thermal Efficiency

In the above graph 10 Indicated thermal efficiency of the blends has been compared with diesel fuel at various loads and it is shown in graph. It is observed that the Indicated thermal efficiency varies over the entire load among them B20 has higher Indicated thermal efficiency in most cases.



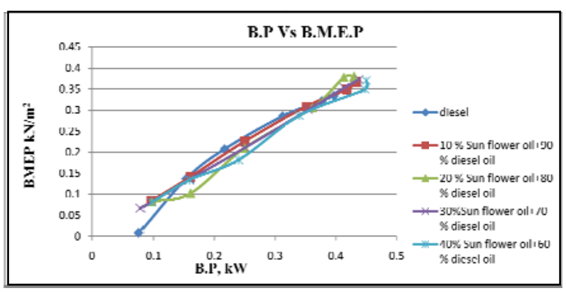
Graph 11: Brake Power Vs Brake Thermal Efficiency

In the above graph 11 Brake thermal Efficiency of the blends has been compared with diesel fuel at various loads and it is shown in graph. It is observed that the Brake thermal Efficiency varies over the entire load among them B20 has higher Indicated thermal efficiency in most cases.



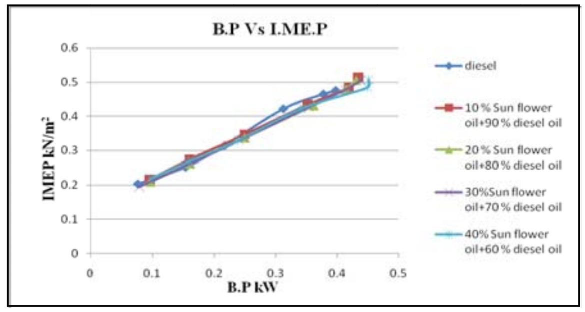
Graph 12: Brake Power Vs Volumetric Efficiency

In the above graph 12 Volumetric Efficiency of the blends has been compared with diesel fuel at various loads and it is shown in graph. It is observed that the Volumetric Efficiency of diesel is more when compared to other blends over the entire load range.



Graph 13: Brake Power Vs Bmep

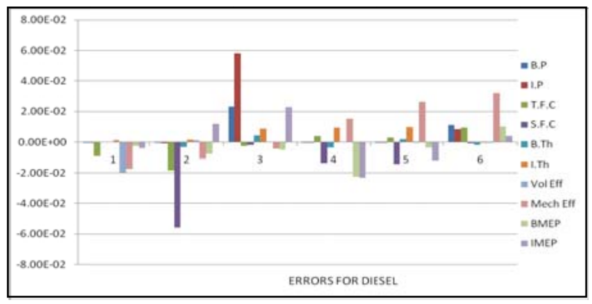
In the above graph BMEP of the blends has been compared with diesel fuel at various loads and it is shown in graph. It is observed that the BMEP varies over the entire load among them B20 and B10 has higher BMEP.



Graph 14: Brake power Vs IMEP

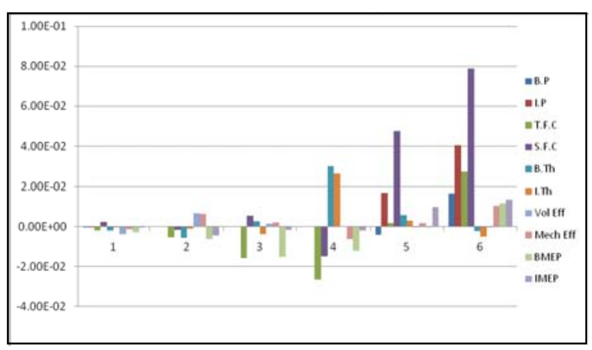
In the above graph 14 IMEP of the blends has been compared with diesel fuel at various loads and it is shown in graph. It is observed that the IMEP is more for the B20 over the entire range of load.

Error between Theoretical and Experimental Values



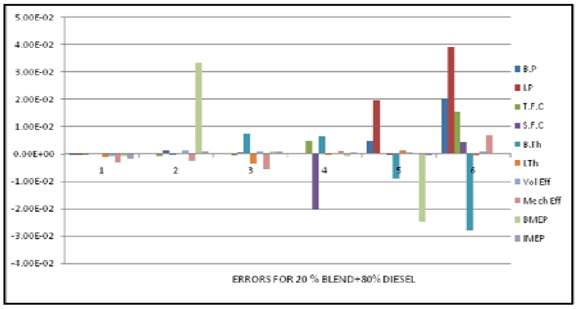
Graph 15: for Diesel

1. The Maximum value of error is for I.P for trail 3 as shown in above graph 15 is 0.058023 when compared to all the readings.
2. The Minimum value of error is for Brake thermal efficiency for trail 1 as shown in above graph 15 is -8.29E-09.
3. The remaining output parameters will have the error range in between the above values as shown in above graph 15



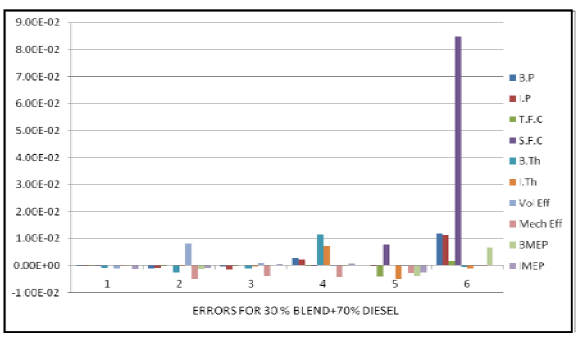
Graph 16: For 10%Blend+90% Diesel

1. The Maximum value of error is for SFC for trail 6 as shown in above graph 156and its value is 0.07869 when compared to all the readings.
2. The Minimum value of error is for Brake power for trail 4 as shown in above graph 16 and its value is -8.54E-11
3. The remaining output parameters will have the error range in between the above values as shown in above graph 16



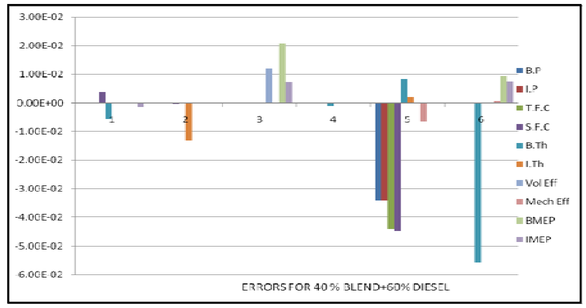
Graph 17: For 20% Blend+ 80%Diesel

1. The Maximum value of error is for I.P for trail 6 as shown in above graph 17and its value is 0.039142when compared to all the readings.
2. The Minimum value of error is for I.P for trail 2 as shown in above graph 17 and its value is 2.92E-11
3. The remaining output parameters will have the error range in between the above values as shown in above graph 17



Graph 18: For 30% Blend+70%Diesel

1. The Maximum value of error is for S.F.C for trail 6 as shown in above graph 18 and its value is 0.084757when compared to all the readings.
2. The Minimum value of error is for TFC for trail 3 as shown in above graph 18 and its value is -1.67E-11
3. The remaining output parameters will have the error range in between the above values as shown in above graph 18



Graph 19: For 40% Blend+60%Diesel

1. The Maximum value of error is for Brake Thermal Efficiency for trail 6 as shown in above graph 19 and its value is -0.05557 when compared to all the readings.
2. The Minimum value of error is for Indicated Thermal Efficiency for trail 4 as shown in above graph 19 and its value is -1.05E-10
3. The remaining output parameters will have the error range in between the above values as shown in above graph 19

VI. CONCLUSION

A Single Cylinder Four Stroke Compressed Ignition Engine was operated successfully using the sunflower oil and diesel blends as fuel. The following conclusions are made based on the experimental and trained results.

a. The Specific fuel Consumption for Blend20 is less when compared to diesel and all other blends over the entire load range for experimental results. Where as for Trained Results Specific fuel consumption for the blends 20 and 30 are low when compared to all other blends and diesel over the entire load range.

b. The efficiencies such as Brake Thermal Efficiency, Indicated Thermal Efficiency and Mechanical Efficiency values for blend 20% is more than diesel and other blends over the entire load range. Where as for Trained Results the efficiencies values for blend 20% and 30% is more than diesel and other blends over the entire load range.

c. The Volumetric Efficiency for diesel is more than all the blends over the entire load range in both experimental and trained results.

d. The Maximum value of error between experimental and theoretical values is 0.084757 and the Minimum value of error between experimental and theoretical values is -1.67E-11

So, it is preferred to use Artificial Neural networks for optimizing the C.I Engine parameters for the following benefits:

1. The performance of engine output parameters has been varied by ANN prediction.
2. The Maximum percentage error between experimental and theoretical values is 0.1691756.
3. Therefore ANN will be a very good tool to optimize engines in the future.

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