

***Waukesha Engine***



**Fuel Ignition Testing for Derived  
Cetane Number of Diesel Fuels**



The Global Leader in Fuel Quality Testing

# What is FIT™?

- Fuel Ignition Tester for Derived Cetane Number of Diesel Fuels
- A refinery laboratory and research ignition quality measurement instrument
- An answer to customer demand for an economical cetane tester that is compact, easy to use and offers low maintenance

The purpose of the FIT unit is to measure the ignition delay of a diesel fuel under prescribed conditions and determine a Derived Cetane Number. The result is equivalent to the Cetane Number as measured by the “Gold Standard” CFR Diesel Cetane Rating Engine. The simple equation used to convert the measured Ignition Delay value into a Derived Cetane Number (DCN) as outlined in the ASTM Method D-7170-06.

Easy installation and operation, low maintenance cost and high throughput (short test cycles) gives the user new possibilities for quality control, research, and optimization of diesel fuel quality.

## Compact Design

This compact desk-top unit is easy to transport and fits readily in an existing laboratory environment.

## Installation

Easy connections to pressurized air and cooling water using industry standard fittings. All you need to provide is a place to set the instrument, electrical connection, instrument and combustion air, venting for exhaust, a Microsoft® Windows® computer, and calibration fuels.

## FIT as a Research Tool

In addition to providing results according to the standard test method, FIT is also an ideal tool for oil producers and engine manufacturers for research in combustion technology. All results are stored in computer files for further analysis.

## Regulatory Compliance

Used to assure that your final product meets ASTM D 975; standard specification for diesel fuel oils.

## Standard Test Method

FIT operates per existing ASTM D 7170-06 and IP PM-DI/06 test methods.

## Calibration

Simple calibration on readily available reference materials, n-Heptane and Methylcyclohexane, by adjusting chamber temperature.

## Design Technology

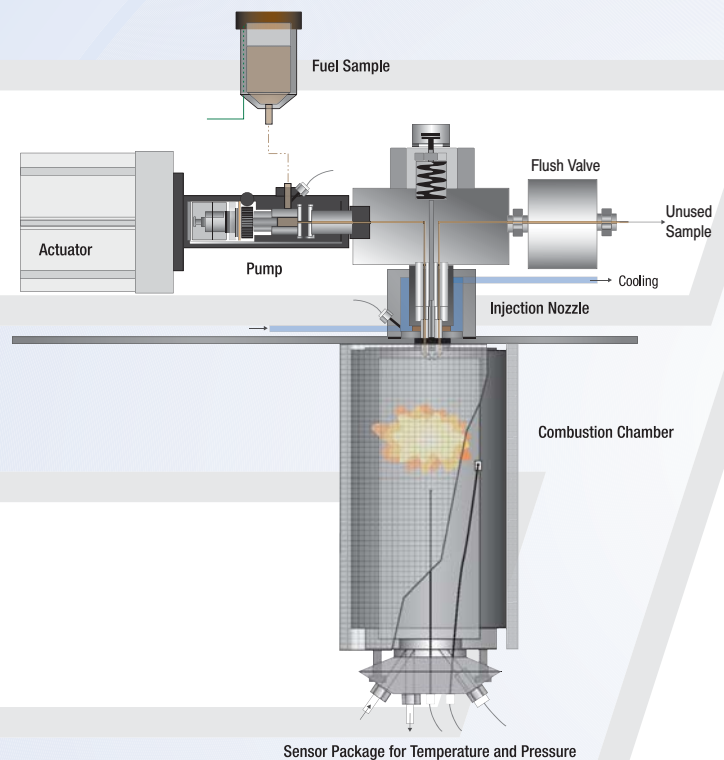
Using an advanced Constant Volume Combustion Chamber (CVCC) equipped with sensors that collect data during the ignition and combustion phase, the FIT unit is designed and optimized to simulate the conditions of the combustion process of an actual diesel engine.

The combustion chamber is pressurized and heated to a specific temperature prior to injection. The fuel self-ignites, and the time from injection to the start of combustion defines the Ignition Delay,

and subsequently the DCN value of the tested fuel.

The instrument's electronics and process control software enable automatic operation to determine the Derived Cetane Number with a high degree of accuracy and repeatability.

## Main Components of FIT



Compact size and quiet operation

# Simple Operation

## Short test cycle

Just 20 minutes before results are available

## Requires no fuel mixing

Reduces error, cycle time, and reference fuel cost

## Automatic operation

Quick and reliable results

## Calculations performed by the FIT software

No need for fuel bracketing, recording measurements, or complex equations

## Testing Capabilities

The test procedure is highly automatic. Just fill the sample reservoir and initiate the operation from the computer screen.

The FIT unit is capable of determining Derived Cetane Number of fuels in a range between 30 and 80 Cetane Number with a repeatability of 0.7 DCN.

The FIT unit is capable of accurately measuring the DCN value of straight diesel fuels, fuel with cetane improvers, bio-diesel and bio-diesel blends.

Test results are immediately available on computer screen, can be stored electronically, and reports printed as a permanent record. The Microsoft® Windows®-based software used with the unit is very user friendly, and data can easily be imported into other programs.

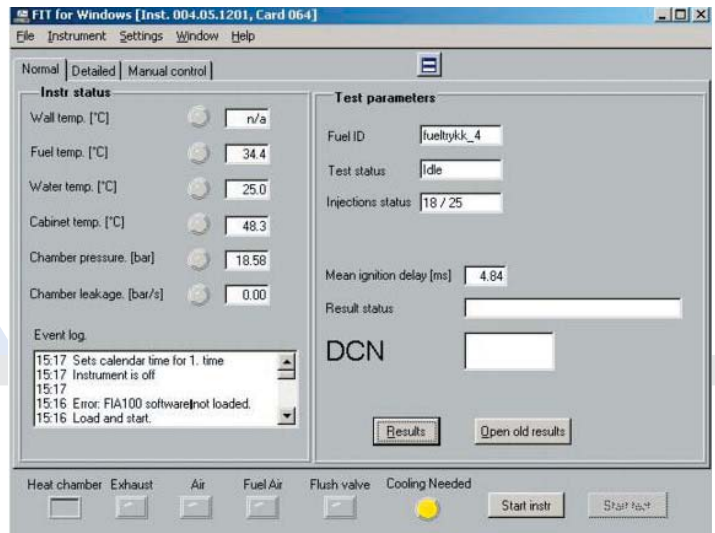
**FIT Results**

Date: 09-23-2004 Time: 09:26:02  
 Instr ID: 005.05.0902 Fuel ID: DFHC02  
 Temp. ref: 571.8  
 Test comment:

Inj no.	Ign. Delay	Charge Press	Max Press	Air Temp	Wall Temp	Water Temp	Fuel Temp	Inj. Period
1	3.61	23.81	10.48	541.4	572.2	29.7	34.0	5.05
2	3.55	24.01	10.61	540.8	571.8	29.7	34.2	5.10
3	3.62	23.96	10.49	541.6	571.8	29.7	34.4	5.05
4	3.59	23.97	10.61	542.0	572.2	29.9	34.4	5.10
5	3.58	24.01	10.52	541.2	571.8	29.9	34.4	5.05
6	3.54	23.95	10.50	542.2	571.6	29.7	34.6	5.10
7	3.56	23.94	10.79	542.0	571.8	29.9	34.8	5.10
8	3.53	24.01	10.72	541.2	571.4	29.7	34.8	5.10
9	3.84	23.93	10.78	540.8	571.4	29.7	34.8	5.10
10	3.63	24.08	10.63	541.6	571.4	29.7	35.0	5.10
11	3.72	24.01	10.65	541.6	571.2	29.7	35.0	5.10
12	3.53	23.90	10.75	541.6	571.2	29.7	35.0	5.15
13	3.56	24.01	10.83	540.8	571.4	29.7	35.0	5.20
14	3.54	23.97	10.96	541.6	571.6	29.7	34.8	5.10
15	3.66	23.98	10.13	541.8	571.4	29.9	35.0	4.90
16	3.54	24.01	10.28	540.8	571.4	29.7	35.0	4.90
17	3.78	23.90	10.15	542.2	571.4	29.7	35.2	4.85
18	3.62	23.94	9.92	540.8	571.4	29.7	35.0	4.85
19	3.48	23.91	10.19	541.4	571.4	29.9	35.0	4.90
20	3.73	23.96	10.50	541.2	571.2	29.7	35.0	5.00
21	3.72	23.98	10.33	541.8	571.6	29.7	35.2	4.95
22	3.59	23.96	9.88	542.6	571.6	29.7	35.2	4.90
23	3.62	24.01	10.13	541.4	571.8	29.7	34.8	4.85
24	3.70	24.00	9.94	541.8	571.6	29.7	35.0	4.80
25	3.51	23.91	10.06	542.2	571.6	29.7	35.0	4.85
Mean	3.61	23.96	10.42	541.5	571.6	29.8	34.8	5.01
Std Dev	0.09	0.06	0.29	0.5	0.3	0.1	0.3	0.12
Min	3.48	23.81	9.88	540.8	571.2	29.7	34.0	4.80
Max	3.84	24.08	10.83	542.6	572.2	29.9	35.2	5.20
Range	0.36	0.27	0.95	1.8	1.0	0.2	1.2	0.40

Charge Press: Min/Max ok (>23.0/<25.0). Avg ok (>23.8/<24.2).  
 Max Press: Range ok (<2.0).  
 Air Temp: Range ok (<5.0).  
 Wall Temp: Min/Max ok (>569.8/<573.8). Avg ok (>571.1/<572.5).  
 Water Temp: Min/Max ok (>29.2/<30.8). Avg ok (>29.7/<30.3).  
 Fuel Temp: Min/Max ok (>32.0/<38.0). Avg ok (>33.0/<37.0).  
 Inj Period: Min/Max ok (>4.0/<6.0). Avg ok (>4.5/<5.5).  
 Result status: Test finished successfully.

Sample Test Report



Microsoft® Windows®-based user interface screen

## Improved Accuracy

### Factory Calibration Curve

Greatly reduced set-up time

### Automated features remove potential of operator error

- No injection timing to advance
- No compression ratio to adjust
- No fuel flow measurement
- No blending of reference fuels

### Cetane giveaway

High accuracy minimizes cetane giveaway

*FIT even accurately determines the influence of cetane improvers*

## Precision and Bias

The precision statements for DCN is based on results from a within-laboratory study conducted in April 2004. The study involved 22 samples, 2 instruments and 1 operator; and covered the range from 40.8 to 58.6 DCN.

DCN:  $r = 0.71$





# FIT Specifications

## Basic FIT unit consists of the following:

### Diesel Fuel Ignition Test Unit

- Constant volume combustion chamber
- Diesel fuel injection system
- Diesel fuel cooling system
- Instrument cabinet
- Electronic board & instrumentation
- Pneumatic actuating system
- Instrument software program

### Circulation Chiller

**Air Reservoir** (max pressure 250 psi)

### Sensor Shim Kit

## Fuel Testing and Results

Fuel types	· Diesel fuels, Cetane range 30-80 CN
Test duration	· 20 minute test cycle
Output	· Calculates Derived Cetane Number based on measured Ignition Delay
Operation of instrument	· Automatic - initiated and controlled through computer
Volume	· 600 cm <sup>3</sup>
Design pressure	· 100 bar

## Test Method

Operates per ASTM D 7170-06 and IP PM-DI/06	
Calibration Materials	· n-Heptane and Methylcyclohexane
Precision (tentative)	· Repeatability (r): $\pm 0.71$ DCN · Reproducibility (R): $\pm 1.5$ DCN

## Injection Unit

Fuel sample volume	· 100 ml for flushing and 40 ml for test
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## Instrument Construction

External dimensions	· 500mmW x 600mmH x 350mmD (20"W x 24"H x 14"D)
Weight	· Approx 40 kg (88lbs)

## Installation Requirements

Computer connection:	Owner/operator must supply the following: <ul style="list-style-type: none"><li>· Microsoft® Windows® 98SE/2000/XP operating system</li><li>· VGA resolution (or higher) video adapter</li><li>· 3 - 4 MB free hard disk space for system software</li><li>· A mouse or other pointing device, CD-ROM</li><li>· One available serial port to FIT</li><li>· Data import into Microsoft® Excel</li></ul>
Main power supply	· 220V, 50 - 60 Hz AC (approx. 2000W)
Serial cable	· Normal "one to one" DB-9 cable with one female and one male connector, provided
Low pressure air connection	· 1/4" BSP Pressure: 6-10 Bar, instrument air
High-pressure air connection	· 1/4" NPT, Pressure: 30 Bar, industrial grade air
Exhaust connection	· 1/4" NPT, The exhaust should be directed through a hose outdoor, or to an air suction device
Cooling water connection	· 1/4" NPT
Cooling water bath	· A thermostat-controlled cooling bath with a circulation pump is provided for cooling the nozzle. The cooling capacity is at least 200W@ 25°C, with 1/4" NPT connections

Specifications and descriptions may be changed without further notification

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CFR Department  
1101 West St. Paul Avenue  
Waukesha, WI 53188-4999  
Ph: (262) 549-2915  
Fax: (262) 549-2960  
waukeshaengine.dresser.com

Form 4084 0906



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