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Thermal Fogger [FAD 21: Farm Implements and Machinery]
Indian Standard

PLANT PROTECTION AND VECTOR CONTROL EQUIPMENT — FOGGING MACHINES — SPECIFICATION

PART 2 AIR-BLOWER TYPE THERMAL FOGGER

ICS 65.060.40
FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Farm Implements and Machinery Sectional Committee had been approved by the Food and Agriculture Division Council.

Thermal fogging equipment are used to produce fog of pesticide formulations. These are used as plant protection and vector control equipment. These work on the principle that when droplets of a volatile liquid come into contact with hot air stream (300 °C ± 30 °C) at high velocity the droplets shear-off and gets vaporized and form a fog when condenses in the atmosphere.

This standard is being published in two parts. Part 1 of this standard covers requirements of pulse-jet type thermal fogger whereas this part (Part 2) covers requirements of air-blower type thermal fogger.

In the preparation of this standard assistance has been derived from WHO specification WHO/VBC/89-973 : 1989 ‘Thermal fogging equipment’ published by World Health Organization, Geneva and approved in 1989.

The composition of the Committee responsible for formulation of this standard is given in Annex B.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2:1960, ‘Rules for rounding off numerical values (revised)’. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.
1 SCOPE
This standard specifies material, constructional, performance and other requirements and method of test of air-blower type thermal fogger.

2 REFERENCES
The following Indian Standards contain provisions which through reference in this text, constitute provision of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

<table>
<thead>
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<th>IS No.</th>
<th>Title</th>
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<tbody>
<tr>
<td>8480:1996</td>
<td>Crop protection equipment — Glossary of terms</td>
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</table>

3 TERMINOLOGY
For the purpose of this standard, the definition given in 3 of IS 8480 shall apply.

4 MATERIALS
All materials used in the construction shall be resistant, or painted or otherwise coated to provide resistance, to insecticides and chemicals used in their formulations under a wide range of climatic conditions and shall meet the performance requirement specified in 8.1.

5 CONSTRUCTIONAL REQUIREMENTS
5.1 General
5.1.1 A thermal fog applicator shall have a system for producing a flow of hot air into which the pesticide formulation is metered.
5.1.2 The air velocity shall be sufficient to shear-off the liquid into droplets and the temperature high enough (300 °C ± 30 °C) to vaporize the droplets rapidly before the hot gas meets the surrounding air at ambient temperature.

5.1.3 There shall be no sharp edges or projections that might injure operators during normal operation.

5.1.4 The fogger shall have a four stroke or turbo petrol engine or equivalent diesel engine to drive an air-blower which shall provide a large volume of air at low pressure to a combustion chamber into which petrol is injected and ignited. The hot air (300 °C ± 30 °C) shall pass to a nozzle in which the pesticide formulation is pumped separately and spread thinly to facilitate vaporization. The nozzle may be fixed or adjustable to alter the angle at which the fog is projected, or it can be transferred to the end of a heat-resistant extension hose.

5.1.5 The complete vehicle-mounted unit shall be robustly constructed for rugged field use, easily mounted on a flat-bed truck or trailer, and so designed that it may be operated from the vehicle cab. The weight of a complete unit assembled for operation, but not including the weight of fuel and pesticide formulation, shall not exceed 250 kg.

5.2 Dimensions
The thermal fogger mounting frame or base shall not exceed 1.20 m × 1.00 m without pesticide tank and 1.8 m × 1.2 m with pesticide tank. The overall height shall not exceed 1.2 m. The tank may be separated from the mounting frame. The size of any separate control panel mounted in a vehicle shall be so designed that interference with normal operation in the cab are avoided.

5.3 Mounting Frames
The mounting frames to support the various components of the aerosol generator shall be robustly constructed to withstand prolonged and variable vibration caused by driving the vehicle along rough roads. The frame shall be equipped with parts or devices to reduce transmission of vibration of the vehicle to components of the thermal fogger.

5.4 Engine
An internal combustion engine of minimum 8 kW rated power shall be provided to drive a blower to provide not less than 4.8 m³ of air per minute to the
nozzle via a combustion chamber to discharge the fog at a maximum output. The engine shall be provided with an electric starter and alternator. The fuel tank capacity shall allow the engine to operate for at least 3 h with the combustion chamber ignition operational. A 50 mesh strainer shall be provided at the inlet of the tank as well as an efficient filter in the supply line between the tank and carburetor. A fine mesh filter or replacement cartridge type filter shall be provided with the engine. An engine identification plate, securely fastened to the engine, shall be provided to show the make, model number, type and power or capacity.

5.5 Air Compressor

A heavy duty air compressor shall be fitted so that its position relative to the engine can be adjusted easily to ensure that any connecting belts, if provided, are correctly tensioned. A strong guard shall be securely fitted to protect the operator from any moving parts. The air intake of the compressor shall be fitted with an air filter of 100 mesh size. The filter shall be of the permanent type and the kind that can be washed and re-oiled periodically. An indicator shall be mounted on the control panel to monitor air pressure so that the operator knows the compressor is functioning correctly, or there shall be an automatic flow control system with a cut-off valve. A device should be affixed to the thermal fogger that will allow combustion only when adequate pressure is present at the combustion chamber for operation.

5.6 Pesticide Tank

5.6.1 General

The pesticide tank shall be fitted either directly to the mounting frame or to a separate frame fixed to the vehicle so that the tank can be easily refilled and removed, when necessary, for cleaning. The outlet from the tank to the nozzle shall be above the floor of the tank so that any solid sediment from the fogging formulations is left in the tank. A drainage plug shall be provided so that the tank can be emptied completely during cleaning.

5.6.2 If pressurized, the tank shall be able to withstand a pressure double the maximum operating pressure without leakage, and shall be fitted with a safety valve.

5.6.3 Capacity

The pesticide tank shall have a capacity of at least 120 l or sufficient capacity to allow fogging for a minimum of 2 h at maximum output. The tank shall be equipped with a metering device to know or to measure the liquid content of the tank.

5.6.4 Filler Opening

The tank shall be designed to allow rapid filling and complete emptying and have an opening in the top of not less than 95 mm in diameter. The filler opening shall be fitted with an airtight lid which is easily fitted and which cannot be removed while the pesticide tank is pressurized.

5.7 Pesticide Metering System

5.7.1 Cut-off Valve

The liquid shall be displaced from the tank by means of air pressure, or alternatively a pump shall be fitted to transfer the liquid to the nozzle. A valve shall be provided between the tank and the nozzle assembly to control the flow of pesticide liquid. An on/off switch shall be provided, mounted on the control panel, to operate the valve. The cut-off valve shall be so designed that all parts are readily accessible for cleaning and replacement.

5.7.2 Delivery Hose

The delivery hose from spray tank to cut-off valve and nozzle shall be made of material resistant to chemical components of pesticide formulations. It shall be of adequate inside diameter to allow easy and continuous flow of the liquid pesticide formulation. The hoses used from pesticide systems shall be readily identifiable and have couplings that are distinguishable from the fuel system to the engine and combustion chambers.

5.7.3 Control System

A control panel shall be provided with a light with an on/off switch to illuminate the panel. The air temperature at or very close to the nozzle shall be monitored and displayed on the control panel. At the option of the purchaser, the control panel shall be of the kind that can be mounted in the cab of the vehicle, behind the cab on the bed of the vehicle, or on the mounting frame of the fogger. In each case, the control panel shall be so mounted that it can be operated by the driver or operator as required by the purchaser.

5.8 Nozzle System

5.8.1 General

The nozzle shall be designed so as to produce a thermal fog using the thermal energy of the combustion chamber, and maximum flow rate outputs. The nozzle shall withstand a temperature of 1 000 °C. The actual temperature of the air at or very close to the nozzle shall be monitored by a pyrometer. If requested by the purchaser, the angle of direction of the nozzle shall be adjustable through 180° horizontally and adjustable vertically to project fog either upwards or downwards to the rear or sides of
the vehicle on which it is mounted. The nozzle shall be designed so that a thermal fog is produced using hot air from the combustion chamber, even with the maximum flow rate. The maximum flow rate shall be not less than 3 l/min and not more than 6 l/min.

5.8.2 Combustion Chamber

A combustion chamber is a chamber in which petrol is ignited to raise the temperature of the air delivered to the nozzle at 300 °C ± 30 °C. Ignition shall be provided by a spark plug, and an electronic ignition unit with a coil. The fuel flow shall be controlled automatically by the engine speed, with a fail-safe system to shut-off all valves if the engine stops.

6 PERFORMANCE

6.1 Engine

When tested in accordance with 8.2, the engine shall comply following requirements:

a) the operational speed shall be within +50 rev/min of that stated by the manufacturer as described in 8.2.1.

b) fuel consumption shall be less than 12 l/h, including operation of combustion chamber ignition to heat the air delivered to the nozzle, as described in 8.2.2.

c) the noise level at maximum speed shall not exceed 90 decibels (dB-A) as described in 8.2.3.

d) the engine shall operate, with no operational problem after 50 h, as described in 8.2.4.

6.2 Air Compressor

6.2.1 When tested in accordance with 8.3.2 the air compressor shall provide an air flow of 4.8 ± 0.2 m³/min to the nozzle.

6.3 Nozzle

6.3.1 When tested in accordance with method specified in 8.4.1 nozzle through output shall not differ by ± 5 percent of the declared value.

6.3.2 When tested in accordance with the method specified in 8.4.2 the droplet size shall be in the range of 8 μm – 20 μm VMD.

6.4 Field Performance and Durability Test

The thermal fogger shall successfully undergo a field trial for a period of 250 h without change in specifications provided by the manufacturer and without development of major and/or frequent breakdowns of any part(s) of the sprayer. Guidelines for field trials of ground spraying equipment including fogging machines are given in Annex A of IS 14855 (Part 1).

7 OTHER REQUIREMENTS

7.1 Spare Parts and Tools

The manufacturer, unless otherwise specified by the purchasing agency, shall supply spare parts, including a spark plug, washers, belts and tools, required for routine replacement during normal use of the equipment over a period of one year. A list of spare parts, illustrated and coded, shall be provided to the purchaser.

7.2 Operation and Maintenance Manual

An adequately illustrated manual on the blower type thermal fogger and its operating procedures, maintenance and repair, in the language specified by the purchasing agency, shall be provided with each unit. The manual shall include complete instructions on the operation, cleaning, maintenance and repair of the equipment with a list of all parts, and also give details of fitting the equipment to various vehicles. The parts of the units that are in contact with the pesticide and may be affected by specific pesticide formulations shall be indicated in the manual. The instructions for the maintenance and repair of the engine, compressor and combustion chamber shall be an integral part of the manual.

7.3 Optional Extras

At the option of the purchasing agency, the thermal fogger may be provided with the following: an extension for the control panel to be mounted in the vehicle cab; extension tubing to operate nozzle for fogging drains.

7.4 Specification Sheet

Manufacturer shall supply the specifications of the machine consisting of the items listed in the data sheet given in Annex A.

8 TEST PROCEDURES

8.0 As far as possible, all tests should be carried out with the complete unit without dismantling any component.

8.1 Test for Resistance of Construction Materials to Chemicals

To test non-metallic parts of the unit that are in contact with pesticide formulations, the following solvent mixture shall be used; 40 percent kerosene (by volume); 20 percent toluene (by volume); and 40 percent xylene (by volume). The parts being tested shall be soaked in the mixture for 72 h at ambient temperature or at 21°C (whichever is the highest). The parts shall then be allowed to dry in the air for a further 24 h. After this exposure, the parts shall not deform and when reassembled shall not leak and shall function normally. Care should be taken when handling this mixture as it is toxic and inflammable.
8.2 Engine Performance Tests

8.2.1 Engine Speed

The engine shall be operated at the speed specified by the equipment manufacturer, and the speed in revolutions per minute checked with a tachometer. All subsequent tests shall be conducted at the same throttle setting/engine speed.

8.2.2 Fuel Consumption

The engine shall be operated until it stops because of shortage of fuel. A measured volume of fuel shall be placed in the fuel tank and the pesticide tank filled with water. The engine shall be operated at maximum speed without the combustion chamber ignition being operational while applying water at the maximum flow rate until the engine stops through shortage of fuel. The period over which the engine operates shall be measured, and then a similar volume of fuel added for a repeat test. The mean fuel consumption, expressed in litres/hour, and the time the machine runs on a full fuel tank shall be calculated. The test shall be repeated with the combustion chamber ignition in use and the time that the machine operates with a full fuel tank shall be calculated.

8.2.3 Noise Level

The noise level shall be measured adjacent to the operator’s ear when he or she is in the operating position. The noise level so measured shall not exceed 90 decibels (dB-A) for a 8 h exposure. Where the noise level cannot be reduced to the acceptable level, the manufacturer shall provide the purchaser initially with suitable ear protectors appropriate to the noise spectrum produced by the fogger.

8.2.4 Durability of Engine

The thermal fogger shall be operated at the maximum flow rate for at least 5 h/day until a total of 50 h of operation has been completed. The engine shall be stopped after each emptying of the fuel tank load and any difficulties in restarting and maintenance required noted. Engine speed shall be checked after every 5 h and the liquid discharge rate and fuel consumption after every 25 h. This 50 h operation shall be completed without any major interruption in the use of the machine.

8.3 Air Compressor Tests

8.3.1 Air Velocity

The air velocity shall be measured at the nozzle and at a point 5 m along the nozzle’s centre axis, horizontally from the nozzle with and without the use of the combustion chamber ignition.

8.3.2 Air Volume

The output of air from the nozzle shall be measured with and without the use of the combustion chamber ignition.

8.3.3 Air Pressure

The pressure of air delivered to the nozzle shall be measured with the help of a pressure gauge.

8.4 Nozzle Performance Tests

8.4.1 Throughput

The throughput shall be measured over the range of restrictors provided with the unit, to determine the time (not less than 1 min) to emit a known volume of liquid. Unless otherwise specified, odourless kerosene shall be the test liquid with viscosity and temperature recorded.

8.4.2 Droplet Size

Glass slides coated with Teflon or Silicon may be placed horizontally on a floor in a chamber (0.5 m x 0.5 m x 0.5 m) into which the fog is projected while travelling past the opening at 1 m/s and allowed to settle for at least 15 min. Method for determining droplet size spectra is given in Annex C of IS 14855 (Part 1). The temperature and humidity during the test shall be recorded. Other proven methods of droplet size determination may be used at the discretion of the testing institute. In particular, advanced laser systems for measuring spray droplet in flight are available in some centres.
ANNEX A
(Clause 7.4)
DATA SHEET FOR AIR-BLOWER TYPE THERMAL FOGGER

A-1 GENERAL INFORMATION
   a) Dimensions:
      1) frame
      2) overall height
   b) Weight (empty)
   c) Construction material for mounting frame
   d) Type of vehicle required for mounting unit

A-2 INSECTICIDE TANK
   a) Capacity
   b) Dimensions:
      1) overall height
      2) floor area
   c) Material for construction
   d) Placement of the tank:
      1) directly on mounting frame
      2) separate frame
   e) Diameter of filler opening
   f) Type of filler opening lid
   g) Maximum pressure tolerance
   h) Type of metering device to show liquid content of tank
   i) Type of safety valve
   j) Type of tank pressure monitoring gauge on control panel

A-3 ENGINE
   a) Make
   b) Type and model
   c) Power
   d) Material of construction
   e) Maximum speed (rev/min)
   f) Fuel consumption (l/h) at maximum speed:
      1) with combustion chamber ignition
      2) without combustion chamber ignition
   g) Fuel type and grade
   h) Fuel tank:
      1) capacity
      2) material of construction
      3) presence of strainer at inlet
      4) fuel filter type
   j) Carburetor:
      1) type
      2) fuel filter type
      3) air filter type
   k) Type of speed control from control panel
   m) Silencer:
      1) type
      2) location
   n) Noise level at maximum speed (dB-A)
   p) Battery:
      1) type
      2) voltage
      3) placement
   q) Spark plug type
   r) Ignition type
   s) Method of starting:
      1) electrical
      2) pulley wheel and rope
   t) Method of stopping
   u) Oil, type and grade

A-4 AIR COMPRESSOR
   a) Type
   b) Make
   c) Material of construction
   e) Connection to the engine (type of drive)
   e) Presence of protecting guard
   f) Type of filter at the air intake
   g) Air velocity at the nozzle:
      1) with combustion chamber ignition
      2) without combustion chamber ignition
   h) Air volume (output from the nozzle):
      1) with combustion chamber ignition
      2) without combustion chamber ignition
   k) Air pressure delivered to the nozzle
   m) Pressure monitoring gauge on control panel
   n) Automatic flow control with cut-off valve on control panel

A-5 DISCHARGE SYSTEM
   a) Insecticide pump, type
   b) Discharge control valve:
      1) type
      2) location
      3) type of on/off switch on control panel
   c) Delivery hoses:
      1) material
      2) internal diameter
      3) type of connection to insecticide tank
   d) Nozzle system:
      1) type
      2) material of construction
      3) maximum temperature it can withstand
      4) output under average working pressure
   e) Droplet size (VMD) (μm):
      1) with combustion chamber ignition
      2) without combustion chamber ignition
   f) Type of monitoring device of air temperature at or very close to, the nozzle
   g) Angle of direction of nozzle:
      1) horizontally
      2) vertically
A-6 COMBUSTION CHAMBER
   a) Material of construction
   b) Type of spark plug
   c) Type of fuel injector
   d) Type of ignition unit
   e) Temperature of air after ignition
   f) Type of control of fuel flow and rate of ignition
   g) Type of fail-safe system to shut-off all valves if engine stops

A-7 CONTROL PANEL
   a) Dimensions
   b) Location
   c) Monitoring gauges on the panel:
      1) flow rate of insecticide
      2) air pressure from compressor
      3) fuel gauge
      4) temperature of air at, or very close to, the nozzle
   d) Controlling switches on the panel
   e) Illuminating device for the panel

A-8 OPTIONAL ITEMS
   a) A variable displacement pump to regulate the flow of insecticide liquid to the nozzle
   b) A variable flow controlled by the vehicle speed
   c) An extension for the control panel to be mounted in the vehicle cab
   d) Extension tubing to operate nozzle for fogging drains

A-9 MARKINGS
   a) Insecticide tank capacity, and markings to indicate different levels

b) Fuel tank capacity
   c) Type of fuel to be used
   d) Open and closed positions of engine choke control
   e) Throttle settings of the engine
   f) Open and closed positions of insecticide valve
   g) Engine specification, make, model number, type, etc
   h) Net weight of complete unit

A-10 ACCESSORIES
   List of accessories, including ear protectors if necessary.

A-11 SPARE PARTS
   List of recommended spare parts to be provided with the unit for replacement during normal use over a period of one year.

A-12 TOOLS
   List of tools to be provided with the unit.

A-13 PUBLICATIONS (samples to be attached)
   a) Manual of operation, language used
   b) Instructions for safe use of the unit
   c) Manual for maintenance and repair, language used
   d) List of spare parts, names and code numbers

Manufacturer’s name and address:
Collaborating centre:
Date completed:
ANNEX B

( Foreword )

COMMITTEE COMPOSITION

Farm Implements and Machinery Sectional Committee, FAD 59

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<td>[Representing Director General (Ex-officio)]</td>
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Member-Secretary
Shri S. K. Singh
Assistant Director (Food & Agri), BIS
Bureau of Indian Standards

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Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of ‘BIS Handbook’ and ‘Standards: Monthly Additions’.

This Indian Standard has been developed from Doc: No. FAD 59 (1000).

Amendments Issued Since Publication

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Printed at Simco Printing Press, Delhi