AP42 Section:	10.5
Reference:	9
Title:	C. T. Van Decar, Plywood Veneer Dryer Control Device, *Journal Of The Air Pollution Control Association*, 22:968, December 1972. 2002 supplement

Sierra
Key
PLYWOOD VENEER AND
LAYOUT OPERATIONS
AP-42 Section 10.3
Reference Number
9

Note on a Plywood Veneer Dryer Control Device

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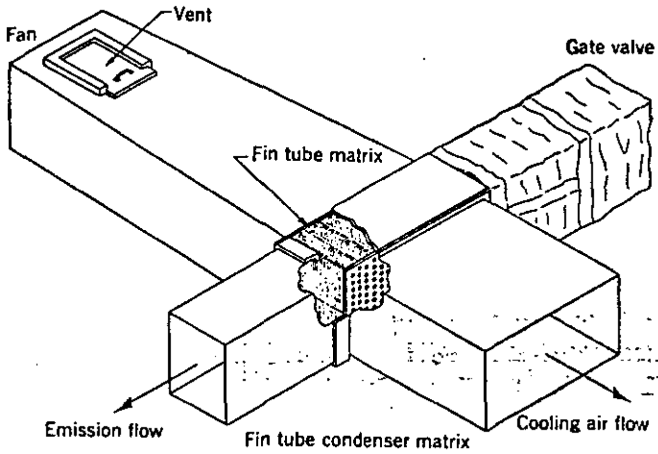

Figure 1. Fin tube condenser matrix.

Condensable hydrocarbons are responsible for the *blue-haze* plume from commercial plywood veneer dryers. This *blue-haze* is a recognized air pollution problem associated with plywood veneer drying and control authorities are developing regulations to limit these hydrocarbon emissions.

The visible *blue-haze* plume consists of hydrocarbon materials that condense after the plume cools below the stack exit temperature of 300–310°F. Douglas Fir and Ponderosa Pine veneer produce the most visible plume. The hydrocarbon emissions from the dryer stacks average 63% condensable and 37% volatile fraction. Study of the condensed hydrocarbon fraction has identified the bulk of the condensate as abietic acid.[1] Also present are sesquiterpenes, fatty acids, resin esters, and resin alcohols. The division temperature between condensable and volatile hydrocarbons is 70°F.

A pilot control device, designed by the author, has successfully demonstrated that the *blue-haze* can be eliminated by condensing the hydrocarbon vapors in a finned tube matrix heat exchanger-condenser. The pilot unit handles 500 cu ft/min of veneer dryer emission gas. The unit was designed using basic heat transfer techniques and knowledge of veneer dryer emissions.

The two factors responsible for the success of the pilot unit are a large surface for condensation and laminar flow. Finned tubing provides the large surface area for condensing the hydrocarbon vapors. To prevent the formation of a hydrocarbon fog while maximizing the condensation of hydrocarbon vapors on the condenser surfaces, a temperature gradient was established by maintaining laminar flow of the emission gas through the unit. If the hydrocarbon vapors had been rapidly cooled below their dew point in the bulk gas stream, the condensing vapors would have formed droplets entrained in the gas stream and thus be emitted to the atmosphere as a visible *blue-haze* plume.

Heat transfer data for air, used in the calculations, was justified due to the low concentration of hydrocarbon condensables present in the veneer dryer emission gas (0.185×10^{-3} lb condensables/lb of air).

The illustration depicts the finned tube matrix condenser and its associated hardware. The rate of cooling air flow is controlled by a vent in the cooling air supply duct and by changing the size of the centrifugal fan driving pulley. The emission gas flow is controlled by a gate valve upstream of the finned tube matrix.

The characteristic *blue-haze* was absent from the control device emission plume during 24 tests; only a light water vapor plume was visible. During four tests there were no visible emissions, not even water vapor.

The finned tube matrix condenser produces an invisible plume when the emission gas exit temperature is between 194 and 230°F. Hydrocarbon removed is a function of temperature drop through the control device and varies from 0.47 ppm/°F at an emission gas exit temperature of 203°F to 0.25 ppm/°F at 113°F and averages 0.32 ppm/°F. The percentage of total hydrocarbon removed (condensable and volatile) varies from 26% at the emission gas exit temperature of 230°F to 50% at 104°F.

An operational unit designed to handle 10,000 SCFM at an emission gas exit temperature of 140°F would cost $18,000 per dryer installation. The operational unit would have the following characteristics:

1. Laminar flow and 140°F emission gas exit temperature.
2. Water cooled, counterflow.
3. Cooling water flow rate of 69 gal/min with an 80°F temperature rise.
4. Overall size: 60 by 60 in. face and 30 in. deep.
5. Self cleaning.
6. Price includes: pump support structure, and TFE surfaced fins.
7. Maintenance and operating cost would be $1200/yr.

Acknowledgment

The subject research was conducted by the author at University of Washington, Seattle, Washington, under a Public Health Service, NAPCA Traineeship grant.

References

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