DESIGN OF A HIGH POWER MICROWAVE APPLICATOR
FOR THE CONTROL ON INSECTS IN STORED PRODUCT

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Summary:

Recent tests of infested, freely flowing, hard red wheat, in a 28GHz microwave applicator indicate that a bounding energy input of 56.8 J/g will produce a mortality of 99% for the least vulnerable species and age level of each of the three major grain pests tested, i.e. hard red wheat, *Triticum aestivum* (L.), infested with pupae, young larvae and eggs of the rice weevil *Sitophilus oryzae* (L), the red flour beetle *Tribolium castaneum* (Herbst), and the lesser grain borer *Rhizopertha dominica* (F.). Amongst these species, the LGB was determined to be the least vulnerable.

A 200kW 28GHz full scale prototype unit has been developed to establish a bounding energy input to produce a mortality of 99% for the least vulnerable specie with a throughput rate of ~24 tonne/h.

Recent Test Results

Recently, tests were conducted on dynamic samples of hard red wheat, *Triticum aestivum* (L.), infested with pupae, young larvae and eggs of the rice weevil *Sitophilus oryzae* (L), the red flour beetle *Tribolium castaneum* (Herbst), and the lesser grain borer *Rhizopertha dominica* (F.). The microwave power source was a 200 kW, 28 GHz, gyrotron that delivered energy to an applicator developed previously to test small samples flowing at an instantaneous rate of 0.54 tonnes/h. The purpose was to determine which of the tested species and age level was the least susceptible to control by energy at the frequency chosen and to perform germination and milling and baking quality evaluations. The least vulnerable species and age level identified will be used in subsequent tests to determine upper energy and temperature bounds for a full scale prototype at ~24 tonnes/h. Tests were also conducted on the least vulnerable species and age level at constant energy input for various input power levels and exposure times to determine whether a minimum exposure time limit exists for the dynamic treatment. The results of these tests are summarized in Table 1.

Table 1. Values of Uload (energy delivered to the sample per unit mass in J/g) at the 99 % level of mortality for rice weevil, red flour beetle and lesser grain borer pupae, young larvae and eggs. Values are determined by probit regression. Volume ratio (vg) = 0.67%,

Species	**Age**	**Uload J/g**	**Remarks**
Rice weevil	pupae	17.643	Most vulnerable
	Young larvae	26.295	
	egg	42.890	
Red flour beetle	pupae	33.050	
	Young larvae	54.858	
	egg	48.454	
Lesser Grain Borer	pupae	27.426	
	Young larvae	36.532	
	egg	56.832	Least vulnerable, bounding case

From Table 1 it is seen that the egg of the lesser grain borer is the least vulnerable of the species tested. In general both the young larvae and eggs of all species were less vulnerable than the pupae. This may be due to decreased radiation coupling caused by the much smaller physical size and energy-absorbing cross section and the shielding effects of the product in which the young larvae and egg reside. The major mechanism of energy transfer in those cases is probably thermal conduction, which is a much slower process than radiation. Nevertheless exposure times of 539 ms were sufficiently long to kill the larvae and eggs but required greater energy input to do so.