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LIMITS ON ^{220}Rn EMISSION FROM STAINLESS STEEL

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This note is to report on the current status of the Oxford group's attempts to measure ^{220}Rn emission from a sample of stainless steel using the cylindrical proportional counter (CPC). The CPC has been described in previous SNO publications, in brief it is a large volume (10 l) single wire proportional counter designed to have a large efficiency for detecting the alpha decay of the short lifetime ($T_{1/2}$=56 s) ^{220}Rn in the ^{232}Th decay chain. The chamber also detects ~1/2 of the subsequent decays of the daughter ^{216}Po (T1/2=0.14 s), which proved valuable as a coincidence to suppress background.

The stainless steel sample used was obtained from Knight Strip Metals. It was 304S31 (which in the US would be called 304, as opposed to 304L) formed into a 0.002" thick strip 12" wide. This strip was wound across its width every 1-2 cm with 0.009" polyester thread and then wound into a tight spiral around a plastic rod. This procedure left an 800. gm "Swiss roll" of stainless with air gaps between each layer of total area 4.0 m^2 which was then fit tightly into a polypropylene pipe. Our Birkbeck collaborators then assayed the remaining sheet at the Holborn lab, they found U at 0+-3 ppb, Th at 17+-12 ppb, and K at 53+-9 ppb.

The polyprop pipe was then introduced into the gas feed line of the CPC, background was measured by replacing the polyprop pipe containing the stainless with an empty one (from the same piece). The highest count rates expected were very low (~few/hour), so in order to reduce the backgrounds to an acceptable level it was necessary to require a coincidence between the ^{220}Rn and the ^{216}Po alphas. In the data reported here only the crudest timing information is used (the ^{216}Po alpha had to follow the alpha from the ^{220}Rn). The data were taken in two sets (which produced consistent results). After the energy cuts there were 76 signal events in 173,539 s and 35 background events in 104,010 s, which gives a detection rate of $(1.01\pm 0.76)\times 10^{-4}$/s. This is reasonably consistent with zero, and gives a two sigma (statistical) upper limit of 8.9 ^{220}Rn atoms/hour emitted from the stainless (taking into account the detection efficiency). The largest systematic uncertainty in this comes from the fraction of the Swiss roll surface from which Rn atoms could escape (the steel is quite springy and it is hard to keep adjacent surfaces from touching), this was conservatively estimated to be 50%.

Two ways to look at this number are to consider: 1.) does it help in understanding the measurements of ^{222}Rn emitted from stainless? and 2.) what does it mean for backgrounds in SNO? The answer to the first question is probably not. If there are 17 ppb of ^{232}Th in the steel, then there are 196 ^{220}Rn atoms/hr being created, and less than 4.5% of these are emitted. Of course, at the two sigma level there may not be any Th in this steel, so we hope to obtain more a more precise determination of the Th content from the Guelph group. Even if Th is present in the steel at this level, this result probably only says that some diffusion process with a time constant long compared to 56 seconds (or a range short compared to 0.001") is operating, which I don't think will shock anyone.

To answer the second question, if one assumes that the number of ^{220}Rn atoms emitted is independent of the thickness of the steel for thicknesses greater than 0.002", then we are saying that there are less than 2.2 ^{220}Rn atoms/m^{2}hr emitted. If the steel we use in SNO is as good as this, then the liner (assumed area = 2500 m^2) will emit less than 5500 ^{220}Rn atoms/hr into the light water. For comparison, if the water is 10-14 gm/gm ^{232}Th then that makes 1000 ^{220}Rn atoms/hr. Obviously, it would be interesting to try to push the level of sensitivity of this measurement another factor of 5-10, and we will attempt to do so.