Lucas Center Agar Phantom Recipe **February10th, 2015**

Phantom is constructed using 17.5 cm diameter spherical container from Dielectric.
Relaxation agent recipe (Schneiders [1]) to provide T1 and T2 comparable to gray matter.
A small amount of NaCl is added to increase the conductivity to mimic the RF load of a head.

1. **Make 10 mM mixture:** **2.908 grams [$Ni(NO_3)_2 . 6H_2O$] per 1 L H_2O**
   or
   2.377 grams [$Ni(Cl_2) . 6H_2O$] per 1 L H_2O
   ***2.377 grams of Nickel Chloride in 1 liter of filtered water**

2. Make agar mixture: 3600 ml H_2O
   400 ml 10 mM $Ni(NO_3)_2$ or $Ni(Cl_2)$
   120 grams Agar
   20 grams NaCl (0.5%)
   1 gram of Sodium Azide (toxic, used to retard growth of mold)

   Use two 2-Liter glass beakers; in each container add:
   1800 ml filtered water
   200 ml Nickel Chloride mixture*
   60 grams of Agar
   10 grams salt
   0.5 grams sodium chloride

3. Boil each liter of mixture **slowly** as follows:
   Do not use heating plate to heat beakers to avoid baking/burning the gel.
   Heat beakers one at a time for 3-5 minutes at high power in microwave.
   Ours is listed as 750 watt; times may scale with power.
   Heat until boiling but do not allow to boil over
   Remove beaker and stir well between periods in microwave.
   Heat until boiling for each period in microwave
   Put other beaker in oven, swapping back and forth.
   Interleave the beakers through the heat/stir cycles
   Constantly observe to ensure that mixture does not boil over
   Titrate time accordingly, reducing the cycle time as the temp rises.
   Repeat heat/stir cycles until the agar is **completely** dissolved
   Liquid should be light brown but clear.
   This entire process will take about 1-2 hours of heating (boiling).
   Immediately pour hot liquid into phantom using funnel while boiling hot.
   If liquid is allowed to cool, it will gel and cannot be used

4. After final pour, purge all air bubbles using a 60cc syringe filled with liquid and connected to tubing inserted to bottom of phantom, filling sphere until liquid runs out hole.
   Doing this will waste some, so be prepared to catch the spillover.
   Plug hole with nylon screw and o-ring gasket while liquid is still hot.

Note that the starting volume of the mixture is greater than $4/3pr^3$ = 2800 ml.
Reduction occurs by boiling of water or spillover; however, there will be at least 500 ml left over.

References

1. Schneiders NJ. Solutions of two paramagnetic ions for use in nuclear magnetic resonance phantoms. Med. Phys. 15, 12-16 (1988).
2. Christoffersson JO. Nickel-Doped Agarose Gel Phantoms in MR Imaging. Acta Radiologica 32 (1991)

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