THE SIGNAL INTENSITY DEPENDENCE ON THE COIL DESIGN FOR C.W. NQR OR NMR SPECTROMETERS

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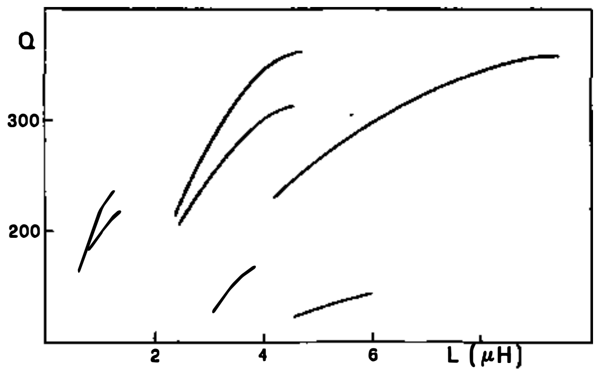
INTRODUCTION

It happens often, when recording NMR or NQR spectra, that the s/n ratio is just for a factor two too small to get out of the spectrum reliable data. In such a situation it is not necessary to take immediately a signal averager and to apply a time consumming averaging technique. Sometimes one can get the desired signal height just by winding a new sample coil. This article analyzes the influence of the coil, and parameters which characterise the r.f. coil, on the signal height for a Robinson type (1) of NQR spectrometer. However, the results are not limited to the particular type of spectrometer, but they can be applied to all c.w. spectrometers.

EXPERIMENTAL and RESULTS

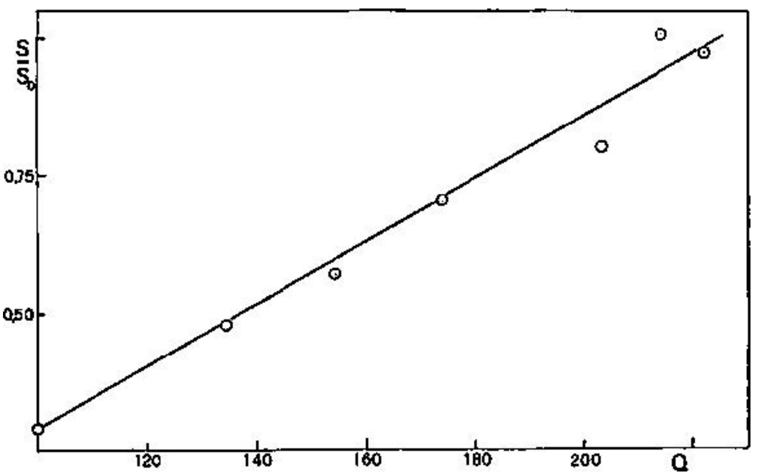
The amplitude of the r.f. voltage at the terminals of the tank circuit's coil is proportional to the Q factor of the coil (2) and therefore it is advisable to use coils with high Q factor. However, we are limited with the size of the sample since we should keep the filling factor close to 1, as well as with the desired magnitude of the inductance L. Taking this into account, we tried to find out the geometry of the r.f. coil with the highest Q factor.

Several coils with different diameters, lenghts, densities of turns and different thicknesses of wire were wound. We wound sets of five coils with the same thickness of wire - d and the same diameter - D, so, that the ratio N^2/l was constant for all five coils. Thus we obtained that the inductance L (3,4) of such a set of coils was a function of just one variable ($L = L(\delta)$ or $L = L(l/D)$), as that the difference in the inductance of such coils was small. On the Fig. 1 the curves $Q = Q(L)$ are shown for all sets of our coils.



Analysing this dependences, taking into account the high frequency ohmic resistance $R = R(L)$ of this coils, we determinated the optimal ratio l/D (lenght of a coil/diameter of the coil) and the optimal density of turns $\delta = l/dN$. With the coils we used, wound with the wire of diameter $1mm \leq d \leq 2mm$ and diameters $1,6cm \leq D \leq 5cm$, we found out that the l/D ratio should be $0,5 \leq l/D \leq 1,5$ and $1,5 \leq \delta \leq 1,7$, in order to have the Q factor for such coils at least equal to 200.
The test of this conclusions was the measurement of the NQR signal with the coils of different Q factor. We decided to measure the NQR signal of ^{35}Cl in $NaClO_3$ at room temperature, where the resonance frequency is equal to 29,9 MHz. The result, i.e. the normalized signal intensity versus Q factor of a coil, can be seen on Fig. 2. Whenever the coil was changed, the oscillator was retuned and the best possible signal was measured. The coil with

the lowest Q factor was wound with the thinnest wire: d = 0,4mm, the subsequent coils were wound with the wires d = 1mm, 1,4mm, 2mm. The highest signal was obtained with the coils of following characteristics: d = 2mm, δ = 1,5 and 1,7, 1/D = 0,5.



We can conclude that the best c.w. signals are recorded when the coil of the tank circuit has the following characteristics:

$$1,5 \leq \delta \leq 1,7 \quad \text{and} \quad 0,5 \leq 1/D \leq 1,5$$

Those requirements can easily be met for all frequencies from 3 MHz to 30 MHz and it is certainly a quick way to improve the spectrometer's performance.

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