§15. Study on AC Losses and Stabilities of the Rutherford Cable

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Superconducting cables of fusion reactor coils are usually composed of stranded wires because they should flow large current as tens kA. One of the important problems for the wires to be solved is stability caused by current sharing between strands. Since the current sharing behaviors may be largely affected by crossover resistances between strands, it is important how to control them in an appropriate value. As far as stabilities are concerned, smaller crossover resistances are better. However, they mean larger ac losses.

The study in FY 1994 aims at obtaining basic data for resolving stabilities of stranded cables.

In order to study the above problems, we have used the Rutherford type cables. Experiments to measure current sharing phenomena in the cables have been carried out by detecting signals with pick-up coils and voltage taps by using the cable test facility at NIFS.

We have used two kinds of cables which have almost same properties but very large different crossover resistances as shown in Table 1.

Table 1 Parameters of the Rutherford cables.

Cable ID	A	B
No. of strand	30	30
Strand dia.(mm)	0.808	0.808
Filament dia.(μm)	6	6
Cable width(mm)	12.125	12.125
Mean thickness(mm)	1.458	1.458
Trans. length(mm)	86	86
Matrix	Cu	Cu/CuMn
Crossover res.(μΩ)	~0.3	~200

We could obtain the voltage wave forms when the cables became in a normal state by firing a local spot heater on a strand. The obtained typical results are shown in Fig. 1, and they show very different patterns between the cables.

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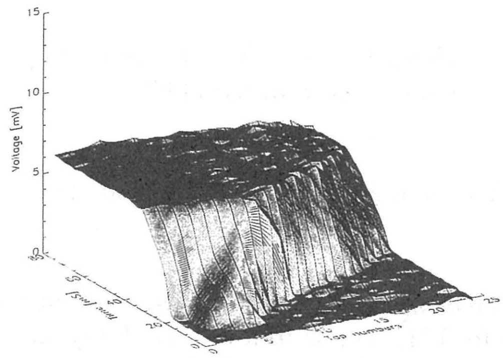
Cable A



Cable B

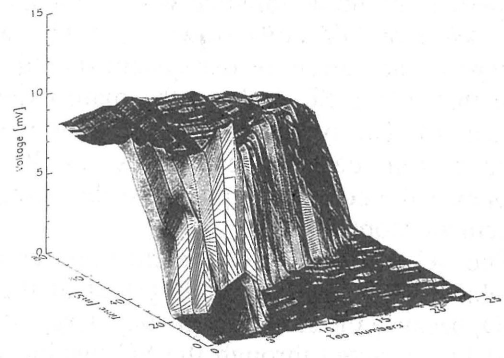


Fig. 1 Voltage wave forms of normal zone of the Rutherford cables.

These different behaviors on the normal zone propagations are closely related to the crossover resistances between strands. The smooth wave forms in the cable A mean better current sharing between strands and more stable against disturbances. On the contrary, in the cable B which has larger crossover resistance the wave forms are much disturbed. This means that the current of strands which become in a normal state cannot be smoothly shared into others.

The minimum quench energy (MQE) was also measured for the cables as shown in Fig. 2.

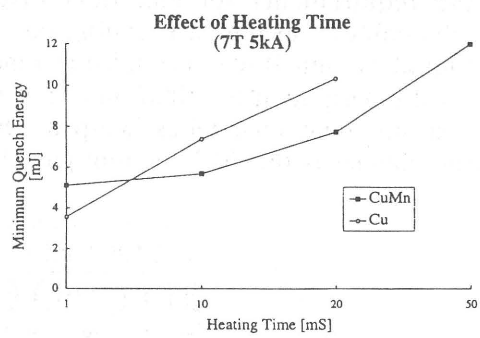


Fig. 2 Measured minimum quench energy vs. heating duration for the cables.

For longer heating duration, the cable A shows more stable characteristics as expected. For the shorter ones, however, the stability behavior is inconsistent with expected one.

The studies for the current sharing of cables are very important and should be expanded further in order to make the stability problems clear.