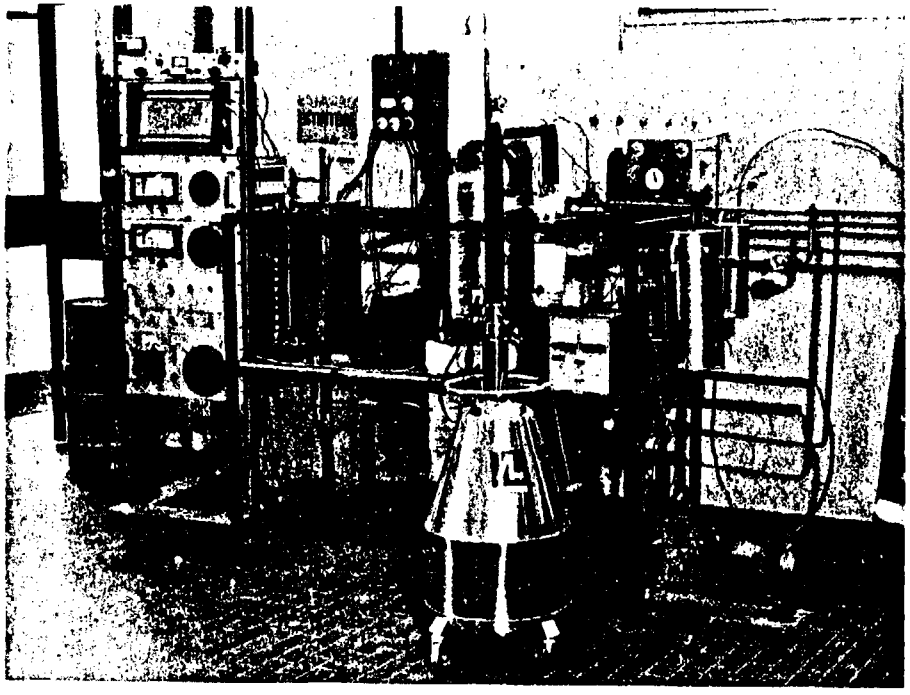

FIG. 5 SODIUM CLEANING LABORATORY FACILITY

SODIUM COMPONENTS CLEANING STATUS IN THE ITALIAN FAST REACTOR PROGRAM

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As a consequence of the Italian Fast Reactor Development, mainly aimed to the PEC project and to the partecipation in the French Superphenix project, it is of increasing importance to set up a reliable method of sodium removal for specific reactor components and related test loops.
So far the problem has been faced only in few occasion and in any case without contamination.
The first problem has been the cleaning of the PEC Fuelling Machine (MCS), that has been ordered by NIRA, PEC main contractor, to the English firm GEC REL, and whose prototype has been already built.

In order to perform the routine maintenance of the machine, GEC REL has proposed an alcohol cleaning method based on the use of 2 - butoxiethanol - NN dimethylformamide mixture (see ref.1).

NIRA, lacking specific experience on this method, has asked AGIP NUCLEARE to verify, in their Medicina sodium laboratory, and to set up the main parameters which control the process in order to obtain the best final cleanliness, also in the narrow gaps, and to avoid stress-corrosion on the materials.

The results of AGIP tests, by use of the circuit shown in fig.1, are:

1) good cleanliness of the exposed surfaces (see fig. 7 and 8);
2) lack of stress-corrosion;
3) best temperature to avoid solvent decomposition 50°C;
4) replacement and agitation of the solvent, desirable to avoid local high temperatures, to reduce the concentration and to improve penetration in the narrow gaps;
5) insufficient cleanliness of the narrow gaps (see fig.9 and 10).

More details can be found on ref. (2), (3), (4).

In order to solve the fifth point a research has been undertaken in the CNEN Casaccia Center where it has been found that the reaction between solvent and sodium in small diameter capillaries and screw threads can be greatly enhanced by applying vacuum conditions (see ref.5).

On the basis of the encouraging results obtained small components of complex geometry have been subsequently cleaned successfully in a suitable facility, see fig.4.

This matter will be explained later in the next session.

As far as the fuelling machine is concerned, a facility is under construction at the Casaccia center to test, on the prototype of the machine, the procedure to be adopted on the reactor.

This facility, on the basis of the experience acquired, is capable of controlling the temperature, the hydrogen development and the sodium concentration in the solvent, it is also capable of recirculating and replacing the solvent. Should the solvent vacuum cleaning technique demonstrate its applicability to the large scale components, the facility is already foreseen for this application.

Another topic has been the need to clean the centrifugal sodium pump of the fuel assembly test circuit CEDI, after a period of functioning in sodium at high temperature to repair the main bearing.

This operation has been performed in a facility built just for this purpose (see fig.2) in the Brasimone Center of CNEN with the collaboration of FIAT, NIRA and the French advice.

The method used in this case has been atomized water in nitrogen atmosphere followed by water rinsing, then the pump has been stripped down, crevices sodium traces have been manually removed, the bearing repaired and the pump placed again in operation with good results (see fig.3, 5, 6).

The same atomized water method has also been used to clean the three main vessels of the PEC mechanism testing circuit (IPM) at the CNEN Casaccia Center. This circuit, having previosly worked in sodium, needed some reconditionning to properly

accomodate the three PEC mechanisms, fuelling machine, hold down mechanism, control rod mechanism.

This operation has been conducted jointly by CNEN, NIRA, FBM and with the French advise.

During the operation some difficulties have been encountered due to the presence undetected of relevant amounts of sodium, probably consequence of an inadequate draining procedure. The difficulties have been sporadic cases of small increase of the pressure above 0,1 kg/cm^2 and of the temperature up to 120°C against an average of 80°C. The final results have been good cleanliness of the vessels with no apparent damages up to day.

In the frame of the agreements CNEN - CEA for the development of the power fast reactors a model of the Superphenix pumps will be tested in sodium at the CNEN Brasimone Center. In order to examine the results of the tests the model will be cleaned with the atomized water method in nitrogen atmosphere like it has already been done on the CEDI pump in a smaller scale.

These have been by now the experiences performed in Italy on the subject of sodium cleaning and it appears obvious that, like in other countries, we are setting up basically two methods to be used according to the different characteristics of components perhaps with the only additional improvement of the solvent vacuum cleaning.

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   P.M.C.S. Load/Unload Machine sodium removal specification

2) AGIP NUCLEARE - T-MG-01-0002
   Prove di lavaggio preliminari

3) AGIP NUCLEARE - T-MG-01-0004
   Rapporto finale prove di lavaggio

4) AGIP NUCLEARE - T-MG-01-0005
   Prove di lavaggio - Rapporto di sintesi

5) B.Di Luca, C.Grasso, M.Spadoni
   Cleaning of small components of comples geometry by means of the sodium alcohol reaction
   CNEN - 1978. To be published

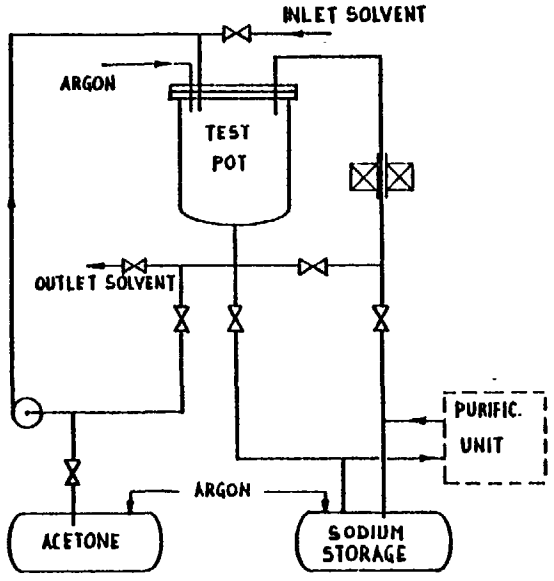


Fig.1 TEST CIRCUIT

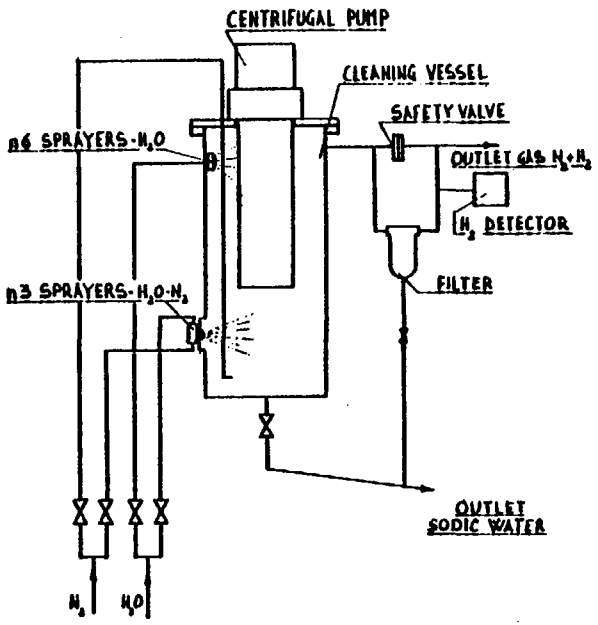


Fig.2- SCHEMATIC DIAGRAM OF CLEANING PLANT FOR CEDI'S CENTRIFUGAL PUMP

Figure 3 CEDI Pump removed from circuit before cleaning

DIAGRAM OF CLEANING PLANT FOR SMALL COMPONENTS OF COMPLEX GEOMETRY.

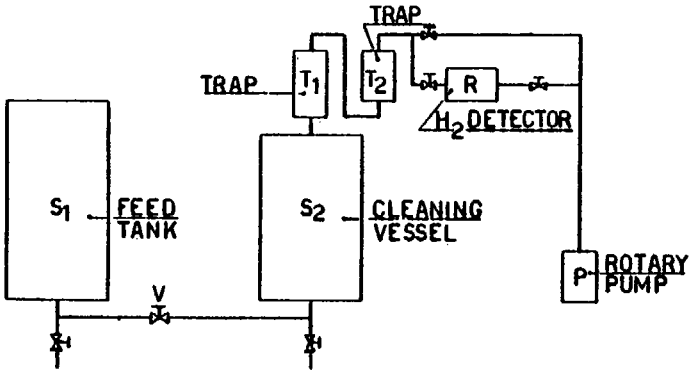


Fig.4

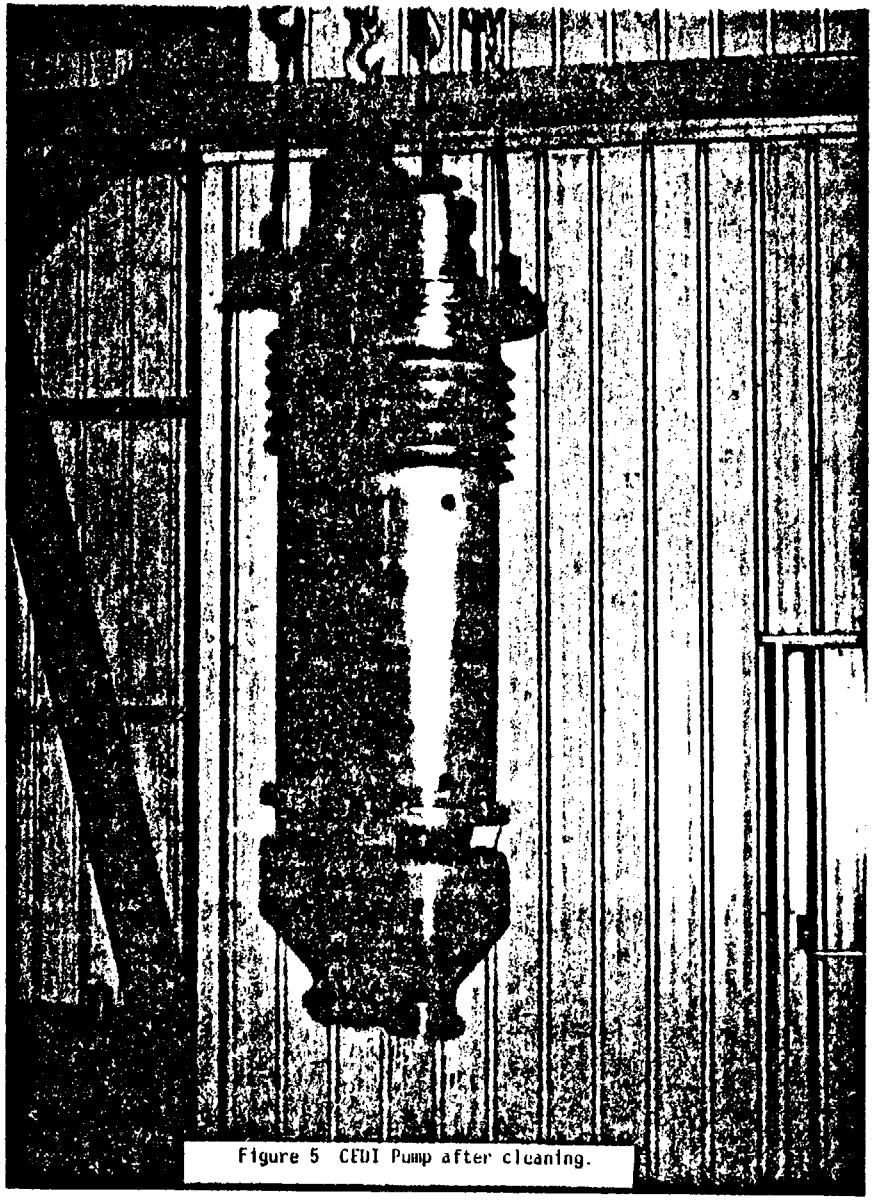


Figure 5 CEDI Pump after cleaning.

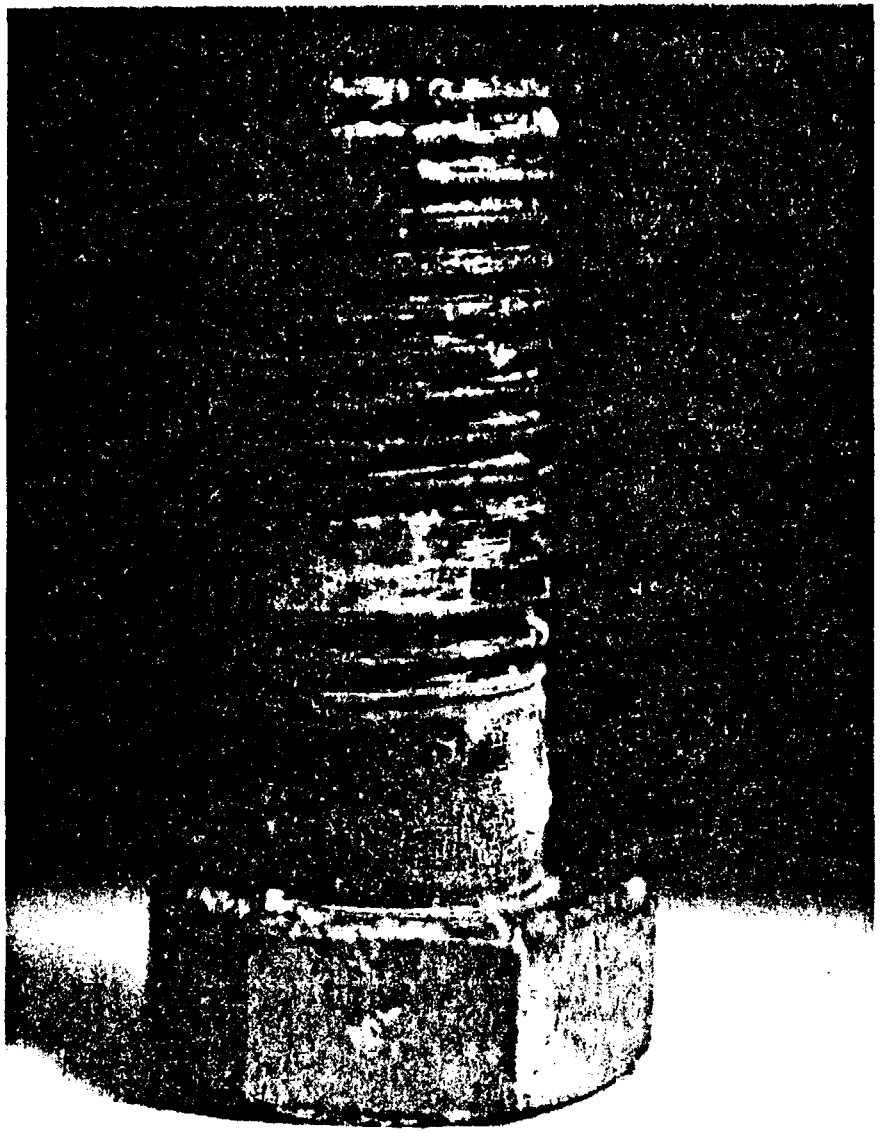


Figure 6 Sodium remaining on screw threads of a CEDI pump bolt after cleaning.

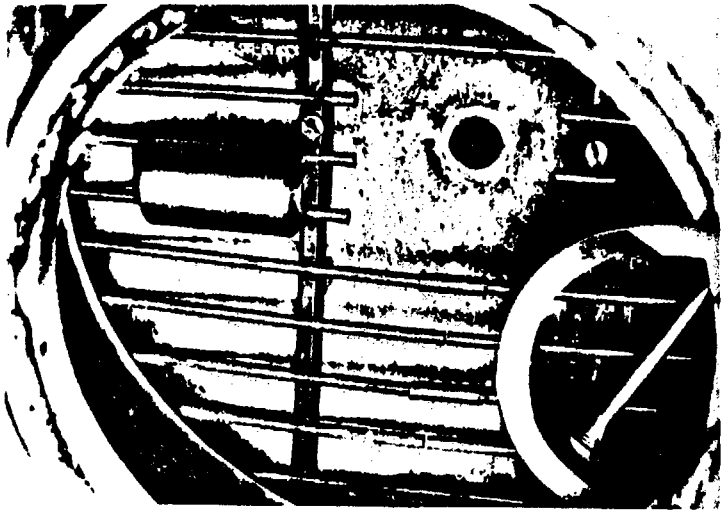
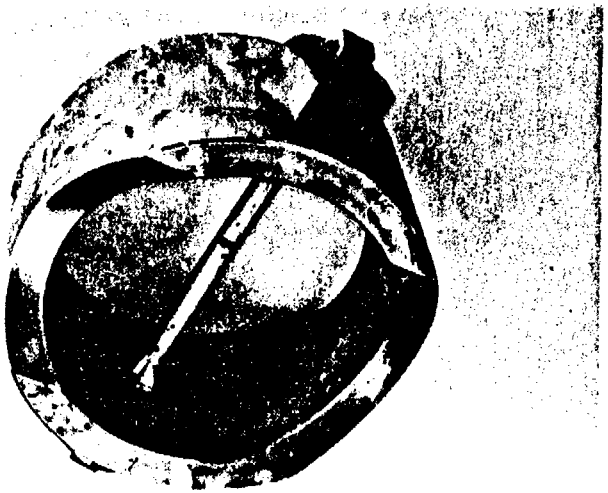


Fig. 7 Cleaned specimens inside the test pot



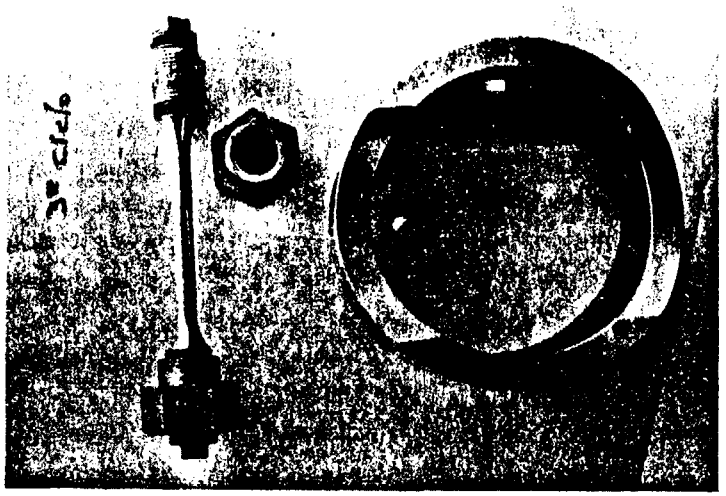


Fig. 9 Stress corrosion specimen stripped down with sodium on the thread

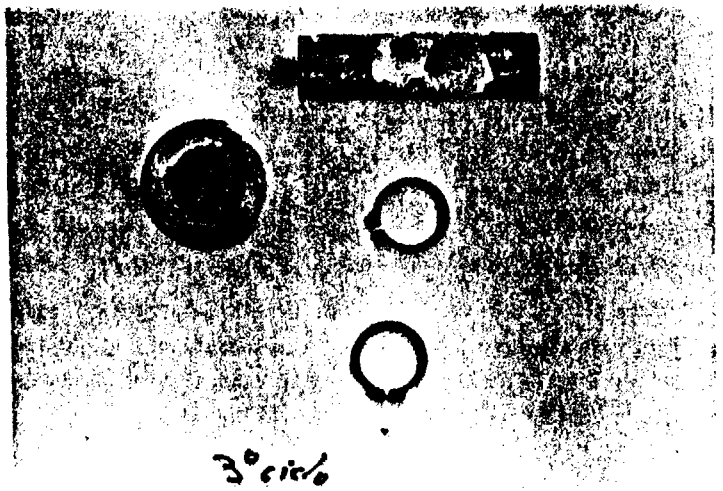


Fig.10 Rolling coupling showing sodium remains

SUMMARY OF SODIUM REMOVAL AND DECONTAMINATION PROGRAMS IN THE USA

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The goals of the United States Department of Energy sodium removal and decontamination programs are 1) to identify plant requirements and develop safe effective processes for sodium removal, both for experimental facilities and for reactor components, 2) to develop effective decontamination processes for removing deposited radioactivity, 3) to establish and put into use a set of workable criteria for requalification and return to service of components after sodium removal and decontamination, 4) to design, build and operate facilities in which to perform the sodium removal and decontamination operations. This paper gives a summary of progress toward each of these goals; details will be presented in other papers at this meeting.

Three basic processes for sodium removal have been investigated extensively: the use of water vapor in an inert carrier gas, the use of an alcohol-type reagent, and evaporation. The process development work on the first two processes has been essentially completed. The evaporative process is still under development, but preliminary parameters have been established.

The water vapor-nitrogen (WVN) process uses a mixture of nitrogen and water vapor in concentrations as high as 15%, at temperatures of 71° to 88°C, followed by rinsing in demineralized water and drying in nitrogen or vacuum. The reaction rate of residual sodium with the water vapor-nitrogen mixture is controlled by measuring the hydrogen concentration of the effluent gas, and increasing or decreasing the water vapor concentration accordingly.