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| ISTC Project No. 3831 |
|  Development and experiments at large-scale installation for heating and retention of corium |
| Final Project Activity Report |
| on the work performed from May 1, 2009 to January 31, 2010  |
| Russian Federal Nuclear Center, Russian Scientific-Research Institute of Experimental Physics Sarov, 607190, Prospect Mira 37, Russia |
| Project Manager | Kondrashenko A. V.Ph.D. |  |
|  |  | Signature / Date |

# Objectives of the Project, Scope of Work and Technical Approach

 The research on the Project belongs to the field of MCCI (Molten Corium Concrete Interaction).

 It is expected during the Project implementation to:

1. Develop the technology of pyrotechnic compound and briquettes producing;
2. Develop the technology of pyrotechnic briquettes initiating
3. Develop the technology of pyrotechnic briquettes dumping into corium.
4. Develop and make the measuring system of melt and concrete temperature diagnosis;
5. Conduct the medium scale experiment on study of corium behavior and melt interaction with concrete;
6. Analyze the results of the experiments.

It is suspected that Work implementation on this project will allow us to experimentally study the process of corium-concrete interaction with the help of PTC technology of corium producing.

During the project implementation it is supposed to experimentally measure the temperature of concrete and corium. Using experimental data it is possible to calculate thermal flows into the concrete and concrete ablation rate.

To experimentally test corium behavior and corium-concrete interaction it is planned to develop the medium scale installation corium heating and the complex of measuring equipment. It is supposed that the installation will have the following characteristics: corium volume ~20 l, corium mass ~100–120 kg, corium temperature ~2500-3000C, heat fluxes towards walls and bottom of the tank ~100-150 kW/m2, corium retention time 10–12 min.

 **1.1 Prospective scheme of the medium scale experiment**

 1.1.1. To heat and localize corium it is supposed to use a cylindrical concrete tank with the following dimensions:

- inner tank diameter ~ 350–400 mm;

- tank height ~ 500 mm;

- tank wall depth ~100–200 mm;

-tank bottom depth ~100–200 mm.

 1.1.2. To create corium and provide the required thermal fluxes and temperatures it is planned to use a rather well known pyrotechnic compound, which burning provides the specific energy release ~2800 kJ/kg per mass unity of the initial PTC.

 1.1.3. The experiment starts with initiating the solid pyrotechnic compound (~25–30 kg) located at the initial moment in the tank. Thus, the initial molten pool is created.

 1.1.4. Afterwards into the molten pool PTC briquettes are dumped (from the height of 1–2 m) at rate of ~0.1–0.2 kg/s. This way we reach the following goals:

 – the mass of the melt is increased up to ~100–110 kg during ~10 min;

 – the PTC energy release inside the melt provides required thermal fluxes into the walls and the bottom of the tank (~100–150 kW/m2 during 10–12 min);

 – the required temperature of the melt is provided (~2500–3000 C).

 1.1.5. The uniformity of energy release inside the melt is achieved by means of dumping the briquettes into the different areas of the melt.

 1.1.6. Additional melt heating is provided by means of ~5 gas burners, located uniformly in a periphery of the tank circle at the height of 100–150 mm above the surface of the melt.

 1.1.7. Molten pool height in ~10–12 min after the start of the experiment reaches the magnitude of ~150–200 mm; the volume of the melt – about 20 l; the density of the melt – 4-5 g/cm3.

 **1.2. Measuring complex**

 During the experiment it is supposed to measure the following parameters:

 – the temperature of melt, concrete walls and bottom of the tank

 – thermal fluxes in the walls and the bottom of the tank;

 – ablation rate of the walls and the bottom.

 It is planned to measure the temperature in two ways:

 – the temperature of the walls and bottom of the tank will be measured by means of thermocouples, mounted into the concrete (~30 thermocouples);

 – the corium temperature will be measured by means of 4-channel pyrometer of visible spectrum range (400–600 nm) by registering corium thermal radiation.

 Thermal fluxes into the walls and the bottom of the tank will be measured by means of the same thermocouples (as in the case of measuring the temperature).

 The ablation rate of the walls and bottom is supposed to be measured by means of the same thermocouples (the measurements are made as the thermocouples stop operating).

# Summary of Technical Progress

## Current Technical Status

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| --- | --- | --- | --- |
| Task / Subtask | Start(quarter) | End(quarter) | Status / Comments |
| 1. | 1 | 3 | Work complete |
| 1.1 | 1 | 3 | Work complete |
| 1.2 | 1 | 3 | Work complete |
| 1.3 | 1 | 3 | Work complete |
| 2 | 1 | 3 | Work complete |
| 2.1 | 1 | 3 | Work complete |
| 2.2 | 1 | 3 | Work complete |
| 2.3 | 1 | 3 | Work complete |
| 3.1 | 1 | 3 | Work complete |
| 3.2 | 1 | 3 | Work complete |
| 3.3 | 1 | 3 | Work complete |
| 3.4 | 1 | 3 | Work complete |

## Tasks according to Work Plan

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| Task 1: Development of the technologies of pyrotechnic briquettes producing, initiating and dumping into corium. |
| **Subtask 1.1: To develop the technology of pyrotechnic briquettes producing.** |

#### State / Situation at the beginning of the Project

We had an experience in producing of PTC briquettes, analogous to the workable ones being developed within the limits of Project #3831

#### Fulfilled work

1. To produce corium the technology of PTC of stoichiometric composition producing was tested and perfected.

2. The technology of producing of single PTC briquettes of the following dimensions (d=50 mm, h=20 mm, m=120 g, ρ=3,05 g/cm3) was tested and perfected.

3. To carry out the medium scale experiment we produced 50 kg of poured PTC and 432 single briquettes with total mass of 52 kg.

4. To dump the briquettes into the melt we used operational briquettes that consisted of 6 single briquettes wrapped into aluminum foil. The operational briquette mass was 720 g and its length was 120 mm. The total number of dumped operational briquettes was 72. The energy release of each operational briquette was ~2 MJ.

#### Results by the end of the Project

1. To produce corium the technology of PTC of stoichiometric composition producing was tested and perfected.

2. The technology of producing of single PTC briquettes of the following dimensions (d=50 mm, h=20 mm, m=120 g, ρ=3,05 g/cm3) was tested and perfected.

#### Individual participants

|  |  |  |
| --- | --- | --- |
| Name | Category | Total days |
| Kondrashenko Aleksey Valerievich | 1 | 15 |
| Subbotin Aleksandr Nikolaevich | 1 | 15 |
| Ogorodnikov Vladimir Aleksandrovich | 1 | 10 |
| Peleskov Stanislav Alekseevich | 1 | 35 |
| Vedeneev Aleksandr Ivanovich | 1 | 24 |
| Tichiy Aleksandr Vladimirovich | 1 | 16 |
| Postnikov Aleksey Yurievich | 1 | 20 |
| Androsov Yury Nikolaevich | 1 | 23 |
| Kremzukov Ivan Konstantinovich | 1 | 21 |
| Pospelov Valery Ivanovich | 1 | 8 |
| Semikov Grigory Yurievich | 1 | 13 |
| Morozov Vladimir Petrovich | 1 | 8 |
| Kuznetsova Valentina Nikolaevna | 1 | 9 |
| Kirina Galina Vasilievna | 1 | 9 |
| Ivanov Dmitry Gennadievich | 1 | 13 |

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| Subtask 1.2: To develop the technology of pyrotechnic briquettes initiating. |

#### State / Situation at the beginning of the Project

We had an experience in initiating of PTC briquettes, analogous to the workable ones being developed within the limits of Project #3831.

#### Fulfilled work

1.The system of PTC initiating by means of electric igniter and the and complex of four gas burners was finalized.

2. The complex of four gas burners for the medium scale experiment was developed and mounted.

#### Results by the end of the Project

1.The system of PTC initiating by means of electric igniter and the and complex of four gas burners was finalized.

2. The complex of four gas burners for the medium scale experiment was developed and mounted.

#### Individual participants

|  |  |  |
| --- | --- | --- |
| Name | Category | Total days |
| Kondrashenko Aleksey Valerievich | 1 | 36 |
| Subbotin Aleksandr Nikolaevich | 1 | 36 |
| Peleskov Stanislav Alekseevich | 1 | 55 |
| Zhuravlev Svyatoslav Matveevich | 1 | 10 |
| Malyshev Aleksandr Yakovlevich | 1 | 13 |
| Vorontsov Aleksey Mikhailovich | 1 | 13 |
| Postnikov Aleksey Yurievich | 1 | 20 |
| Bugrov Aleksandr Aleksandrovich | 1 | 13 |
| Androsov Yury Nikolaevich | 1 | 35 |
| Pospelov Valeriy Ivanovich | 1 | 8 |
| Kremzukov Ivan Konstantinovich | 1 | 25 |
| Semikov Grigory Yurievich | 1 | 16 |
| Morozov Vladimir Petrovich | 1 | 8 |
| Kuznetsova Valentina Nikolaevna | 1 | 9 |
| Kirina Galina Vasilievna | 1 | 9 |
| Ivanov Dmitry Gennadievich | 1 | 24 |
| Izutov Anatoly Alekseevich | 1 | 12 |
| Pospelov Mark Valerievich | 1 | 20 |
| Sirenko Aleksandr Vasilievich | 1 | 20 |
| Galagan Evgeniy Prokofievich | 1 | 15 |
| Tshagin Igor Aleksandrovich | 1 | 14 |
| Kaganov Vyacheslav Fyodorovich | 1 | 11 |
| Kuznetsov Valery Viktorovich | 1 | 20 |
| Sazonov Nikolay Ivanovich | 1 | 20 |
| Ogorodnikov Vladimir Aleksandrovich | 1 | 12 |
| Vedeneev Aleksandr Ivanovich | 1 | 24 |
| Tichiy Aleksandr Vladimirovich | 1 | 14 |
| Androsov Yury Nikolaevich | 1 | 13 |

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| Subtask 1.3: To develop the technology of pyrotechnic briquettes dumping into corium. |

#### State / Situation at the beginning of the Project

We had no experience in dumping PTC briquettes into corium.

#### Fulfilled work

1. For dumping operational PTC briquettes into corium we used the following technology:

1. A steel chute with inner diameter of 80 mm and length of 520 m, located an angle of ~600 to horizon.

2. The lower end of the chute was 610 mm above the installation with corium.

3. The chute was pointed into the bottom center of the tank.

#### Results by the end of the Project

The finalized technology allowed to dump all prepared operational PTC briquettes (72 briquettes with total mass of 52 kg).

#### Individual participants

|  |  |  |
| --- | --- | --- |
| Name | Category | Total days |
| Kondrashenko Aleksey Valerievich | 1 | 20 |
| Subbotin Aleksandr Nikolaevich | 1 | 14 |
| Peleskov Stanislav Alekseevich | 1 | 55 |
| Zhuravlev Svyatoslav Matveevich | 1 | 8 |
| Malyshev Aleksandr Yakovlevich | 1 | 30 |
| Vorontsov Aleksey Mikhailovich | 1 | 13 |
| Postnikov Aleksey Yurievich | 1 | 16.5 |
| Bugrov Aleksandr Aleksandrovich | 1 | 13 |
| Androsov Yury Nikolaevich | 1 | 35 |
| Pospelov Valeriy Ivanovich | 1 | 8 |
| Kremzukov Ivan Konstantinovich | 1 | 23 |
| Semikov Grigory Yurievich | 1 | 16 |
| Morozov Vladimir Petrovich | 1 | 8 |
| Kuznetsova Valentina Nikolaevna | 1 | 9 |
| Kirina Galina Vasilievna | 1 | 9 |
| Ivanov Dmitry Gennadievich | 1 | 20 |
| Pospelov Mark Valerievich | 1 | 24 |
| Sirenko Aleksandr Vasilievich | 1 | 20 |
| Vedeneev Aleksandr Ivanovich | 1 | 24 |
| Tichiy Aleksandr Vladimirovich | 1 | 14 |

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| Task 2: Development of the measuring equipment complex for the diagnosis of corium temperatures, thermal fields in concrete. |
| **Subtask 2.1: To develop and make the measuring system of the melt temperature by means of pyrometry.** |

#### State / Situation at the beginning of the Project

We had some experience in measuring the temperature of heated surfaces by means of pyrometers.

#### Fulfilled work

1. To measure the corium-concrete surface temperature 3 quartz light guides (of 400 mkm in diameter put into the steel pipes of 4 mm in diameter) were mounted into the concrete tank.

2. Above the light guide of 400 mkm in diameter at the corium-concrete surface foil was located.

#### Results by the end of the Project

1. During the medium scale experiment foil radiation was registered by means of pyrometer of visible spectrum range.

2. To register corium surface thermal radiation a 4-channel pyrometer was developed. As photodetectors photoelectronic multipliers (PEM) Hamamatsu R1925A were used. PEM load resister output current flows to the input of a registrator (oscilloscope, analog-digital converter).

#### Individual participants

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| --- | --- | --- |
| Name | Category | Total days |
| Kondrashenko Aleksey Valerievich | 1 | 9 |
| Ogorodnikov Vladimir Aleksandrovich | 1 | 30 |
| Esin Oleg Aleksandrovich | 1 | 12 |
| Mikhaylov Anatoly Leonidovich | 1 | 5.5 |
| Rozhdestvensky Boris Fyodorovich | 1 | 5.5 |
| Tkachenko Igor Anatolievich | 1 | 8 |
| Mochalov Mikhail Alekseevich | 1 | 28 |
| Mezhevov Aleksandr Borisovich | 1 | 18 |
| Kirshanov Sergey Ivanovich | 1 | 18 |
| Degtaryev Boris Petrovich | 1 | 4 |
| Petrazhitsky Aleksandr Vladimirovich | 1 | 4 |
| Peshkov Viktor Vladimirovich | 1 | 12 |
| Erunov Sergey Vladimirovich | 2 | 18 |
| Peshekhodko Vladislav Yurievich | 2 | 6 |
| Blikov Anton Olegovich | 2 | 9 |
| Dontsov Aleksey Nikolaevich | 2 | 9 |
| Aksenov Aleksandr Yanovich | 1 | 16 |
| Funtikov Aleksandr Iosifovich | 1 | 10 |
| Ivanova Tatyana Sergeevna | 1 | 10 |
| Aksenov Aleksandr Yanovich | 1 | 8 |

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| **Subtask 2.2: To develop and make the measuring system of the melt temperature and heat flows in concrete by means of thermocouples.** |

#### State / Situation at the beginning of the Project

We had some experience in temperature measuring in various substances by means of thermocouples.

#### Fulfilled work

1. The system for the diagnosis of temperature was developed and installed (34 thermocouples) into the concrete tank for the medium scale experiment.

2. 22 thermocouples (Type-K) were disposed into the bottom of the concrete tank at the depth of 5 (3 units), 10 (5 units), 15 (3 units), 20 (5 units) and 30 (4 units) mm respectively. Two thermocouples (W-Re) were disposed at the bottom surface (0 mm).

3. 12 thermocouples (Type-K) were disposed into the walls of the concrete tank at the depth of 5 (6 units), 15 (2 units), 20 (2 units) and 25 (2 units) mm respectively.

#### Results by the end of the Project

During the medium scale experiment 28 thermocouples provided reliable measurements.

#### Individual participants

|  |  |  |
| --- | --- | --- |
| Name | Category | Total days |
| Kondrashenko Aleksey Valerievich | 1 | 14 |
| Ogorodnikov Vladimir Aleksandrovich | 1 | 36 |
| Esin Oleg Aleksandrovich | 1 | 28 |
| Mikhaylov Anatoly Leonidovich | 1 | 5.5 |
| Rozhdestvensky Boris Fyodorovich | 1 | 5.5 |
| Tkachenko Igor Anatolievich | 1 | 8 |
| Mochalov Mikhail Alekseevich | 1 | 36 |
| Mezhevov Aleksandr Borisovich | 1 | 18 |
| Kirshanov Sergey Ivanovich | 1 | 18 |
| Peshkov Viktor Vladimirovich | 1 | 26 |
| Erunov Sergey Vladimirovich | 2 | 26 |
| Peshekhodko Vladislav Yurievich | 2 | 18 |
| Blikov Anton Olegovich | 2 | 15 |
| Dontsov Aleksey Nikolaevich | 2 | 9 |
| Aksenov Aleksandr Yanovich | 1 | 14 |
| Subbotin Aleksandr Nikolaevich | 1 | 10 |
| Funtikov Aleksandr Iosifovich | 1 | 10 |
| Ivanova Tatyana Sergeevna | 1 | 10 |

**Subtask 2.3: To conduct the calibration tests. Test result analysis.**

#### State / Situation at the beginning of the Project

We had some experience in calibrating the system for the diagnosis of temperature by means of pyrometry and thermocouples.

#### Fulfilled work

1. Chromel-alumel thermocouples were calibrated by the well known temperatures of liquid nitrogen (-196°С) and boiling water (100°С). Using obtained data we graphed calibration curves that were used for processing the experimental results, acquired during the medium scale experiment.

2. For etalon lamps SIRSh6-40 (tape line 1 mm) and SI8-300 (tape line 3 mm) by means of precision pyrometer EOP-66 the calibration was made to later on use in the medium scale experiment.

3. Measured bright temperature of SIRSh6-40 at the heating current of Ih=5.7 A at the wavelength of λ = 0.59 mkm was amounted to Тs = 1978 K.

4. Measured bright temperature of SI8-300 at the heating current of Ih=16.03 A was amounted to Тs=1900 K.

#### Results by the end of the Project

The temperature measuring system calibration was made by means of pyrometry and thermocouples to measure concrete and corium temperature during the medium scale experiment

#### Individual participants

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| --- | --- | --- |
| Name | Category | Total days |
| Kondrashenko Aleksey Valerievich | 1 | 10 |
| Ogorodnikov Vladimir Aleksandrovich | 1 | 36 |
| Esin Oleg Aleksandrovich | 1 | 28 |
| Mikhaylov Anatoly Leonidovich | 1 | 5.5 |
| Rozhdestvensky Boris Fyodorovich | 1 | 5.5 |
| Tkachenko Igor Anatolievich | 1 | 8 |
| Mochalov Mikhail Alekseevich | 1 | 36 |
| Mezhevov Aleksandr Borisovich | 1 | 18 |
| Kirshanov Sergey Ivanovich | 1 | 18 |
| Peshkov Viktor Vladimirovich | 1 | 20 |
| Erunov Sergey Vladimirovich | 2 | 24 |
| Peshekhodko Vladislav Yurievich | 2 | 18 |
| Blikov Anton Olegovich | 2 | 15 |
| Dontsov Aleksey Nikolaevich | 2 | 10 |
| Aksenov Aleksandr Yanovich | 1 | 14 |
| Subbotin Aleksandr Nikolaevich | 1 | 5 |
| Funtikov Aleksandr Iosifovich | 1 | 10 |

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| Task 3: Development of the medium scale installation for corium heating with characteristics: corium volume ~15-18 L corium mass ~100-120 kg, corium temperature ~2500-3000C, heat fluxes towards walls and a bottom of a tank ~100 kw/m2, melt retention time 10-12 mins. |
| **Subtask 3.1: To manufacture units, to mount a tank and a system for throwing pyrotechnic briquettes into corium.** |

#### State / Situation at the beginning of the Project

#### We had no experience in development of corium heating installations.

#### Fulfilled work

1. A concrete tank was prepared for the medium scale experiment (102 kg of corium) with volume of ~55 l. Tank dimensions: inner diameter=400 mm, depth=480 mm, wall and bottom thickness=100 mm.

2. The technology of producing of single PTC briquettes of the following dimensions (d=50 mm, h=20 mm, m=120 g, ρ=3,05 g/cm3) was tested and perfected.

3. A steel chute with inner diameter of 80 mm and length of 520 m, located an angle of ~600 to horizon.

4. The lower end of the chute was 610 mm above the installation with corium.

5. The chute was pointed into the bottom center of the tank.

6. During the medium scale experiment the video recording was made by means of 2 cameras.

#### Results by the end of the Project

1. A concrete tank was prepared for the medium scale experiment (102 kg of corium) with volume of ~55 l.

2. The finalized technology allowed to dump during the medium scale experiment all prepared operational PTC briquettes into the concrete tank (72 briquettes with total mass of 52 kg).

#### Individual participants

|  |  |  |
| --- | --- | --- |
| Name | Category | Total days |
| Kondrashenko Aleksey Valerievich | 1 | 6 |
| Ogorodnikov Vladimir Aleksandrovich | 1 | 10 |
| Funtikov Aleksandr Iosifovich | 1 | 14 |
| Ivanova Tatyana Sergeevna | 1 | 10 |
| Degtaryev Boris Petrovich | 1 | 4 |
| Petrazhitsky Aleksandr Vladimirovich | 1 | 4 |
| Peshkov Viktor Vladimirovich | 1 | 8 |
| Erunov Sergey Vladimirovich | 2 | 8 |
| Peshekhodko Vladislav Yurievich | 2 | 6 |
| Blikov Anton Olegovich | 2 | 7 |
| Dontsov Aleksey Nikolaevich | 2 | 4 |
| Subbotin Aleksandr Nikolaevich | 1 | 5 |
| Mochalov Mikhail Alekseevich | 1 | 4 |

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| **Subtask 3.2: To mount a measuring complex for diagnosing corium temperatures, thermal fields and thermal fluxes in concrete.** |

#### State / Situation at the beginning of the Project

We had some experience in measuring the temperature of various substances by means of thermocouples.

#### Fulfilled work

1. The system for the diagnosis of temperature was developed and installed (34 thermocouples) into the concrete tank for the medium scale experiment.

2. To measure the corium-concrete surface temperature 3 quartz light guides (of 400 mkm in diameter put into the steel pipes of 4 mm in diameter) were mounted into the concrete tank.

#### Results by the end of the Project

1. During the medium scale experiment 28 thermocouples provided reliable measurements for ~30 min.

2. In the medium scale experiment foil radiation was registered by means of the developed pyrometer in the visible spectrum range for ~60 s.

#### Individual participants

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| --- | --- | --- |
| Name | Category | Total days |
| Kondrashenko Aleksey Valerievich | 1 | 10 |
| Ogorodnikov Vladimir Aleksandrovich | 1 | 12 |
| Subbotin Aleksandr Nikolaevich | 1 | 14 |
| Funtikov Aleksandr Iosifovich | 1 | 13 |
| Ivanova Tatyana Sergeevna | 1 | 10 |
| Peshkov Viktor Vladimirovich | 1 | 14 |
| Erunov Sergey Vladimirovich | 2 | 12 |
| Peshekhodko Vladislav Yurievich | 2 | 10 |
| Blikov Anton Olegovich | 2 | 7 |
| Dontsov Aleksey Nikolaevich | 2 | 4 |
| Mochalov Mikhail Alekseevich | 1 | 8 |
| Sirenko Aleksandr Vasilievich | 1 | 20 |
| Kaganov Vyacheslav Fyodorovich | 1 | 11 |
| Galagan Evgeniy Prokofievichα | 1 | 15 |
| Tshagin Igor Aleksandrovich | 1 | 14 |

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| **Subtask 3.3: To conduct the medium scale experiments on study of corium behavior and melt interaction with concrete.** |

#### State / Situation at the beginning of the Project

We had no experience of conducting MCCI experiments.

#### Fulfilled work

1. To carry out the medium scale experiment we produced 50 kg of poured PTC and 72 operational briquettes with total mass of 52 kg.

2. During the medium scale experiment (~10 min) all PTC briquettes (72) were dumped into corium.

3. To dump operational PTC briquettes into corium a steel chute was used with inner diameter of 80 mm and length of 520 m, located an angle of ~600 to horizon.

4. The complex of four gas burners for PTC initiating during the medium scale experiment was developed and mounted.

5. To measure the corium-concrete surface temperature 28 thermocouples and 3 quartz light guides (of 400 mkm in diameter put into the steel pipes of 4 mm in diameter) were mounted into the concrete tank.

#### Results by the end of the Project

#### The medium scale experiment with characteristics: corium volume ~25 L, corium mass ~105 kg, corium temperature ~2500-3000C, heat fluxes towards walls and a bottom of a tank ~100-200 kw/m2, melt retention time 10-12 min was conducted.

#### Individual participants

|  |  |  |
| --- | --- | --- |
| Name | Category | Total days |
| Kondrashenko Aleksey Valerievich | 1 | 7 |
| Ogorodnikov Vladimir Aleksandrovich | 1 | 10 |
| Subbotin Aleksandr Nikolaevich | 1 | 10 |
| Funtikov Aleksandr Iosifovich | 1 | 14 |
| Peshkov Viktor Vladimirovich | 1 | 14 |
| Erunov Sergey Vladimirovich | 2 | 12 |
| Peshekhodko Vladislav Yurievich | 2 | 10 |
| Blikov Anton Olegovich | 2 | 7 |
| Dontsov Aleksey Nikolaevich | 2 | 4 |
| Mochalov Mikhail Alekseevich | 1 | 12 |
| Sirenko Aleksandr Vasilievich | 1 | 20 |

**Subtask 3.4: To analyze the results of the experiments.**

#### State / Situation at the beginning of the Project

We had no experience of analyzing the results of MCCI experiments.

#### Fulfilled work

1. The results of medium scale experiment were obtained by means of 28 thermocouples (26 Type-K and 2 W-Re) for ~30 min.

2. In the medium scale experiment foil radiation was registered by means of the developed pyrometer in the visible spectrum range for ~60 s.

3. Magnitudes of thermal fluxes into the concrete were estimated using the experimental results obtained by means of thermocouples.

#### Results by the end of the Project

After the medium scale experiment molten corium froze and formed a cylindrical “tablet” with the following parameters (Fig. 10-13):

1. Tablet mass ~ 105 kg;

2. Tablet diameter ~450 mm;

3. Tablet thickness ~160 mm;

4. Tablet volume ~ 25 l;

5. Tablet density ~4.2 g/cm3.

6. Iron is apparently uniformly distributed inside the tablet because a magnet sticks to the each tablet side well.

7. During the medium scale experiment corium temperature was ~2500-3000 C,

8. During the medium scale experiment heat fluxes towards walls and a bottom of a tank were ~100-200 kW/m2

#### Individual participants

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| --- | --- | --- |
| Name | Category | Total days |
| Kondrashenko Aleksey Valerievich | 1 | 2 |
| Mochalov Mikhail Alekseevich | 1 | 4 |
| Peshkov Viktor Vladimirovich | 1 | 6 |
| Erunov Sergey Vladimirovich | 2 | 4 |
| Peshekhodko Vladislav Yurievich | 2 | 4 |

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| Task 0: Project Management |

Fulfilled work

Materials and equipment acquisition, delivery, accounting and storage

Putting the equipment into operation, exploitation and repair.

Book-keeping, paper work.

Writing of the quarter, annual and final reports.

#### Individual participants

|  |  |  |
| --- | --- | --- |
| Name | Category | Total days |
| Kondrashenko Aleksey Valerievich | 1 | 52 |
| Subbotin Aleksandr Nikolaevich | 1 | 67 |
| Boychenko Tatyana Nikolaevna | 4 | 16 |
| Lyubimtsev Dmitry Alekseevich | 4 | 16 |
| Kopylova Lyubov Pavlovna | 4 | 16 |
| Valiulina Valeria Kamilevna | 4 | 16 |
| Denisov Mikhail Borisovich | 4 | 16 |
| Grushko Aleksandr Vasilievich | 4 | 12 |
| Ignatov Oleg Leonidovich | 4 | 6 |
| Pozdnakov Mikhail Ivanovich | 4 | 16 |
| Isaeva Tatyana Borisovna | 4 | 16 |
| Tishenko Nadezhda Khoryevna | 4 | 16 |
| Kulakov Evgeny Vyacheslavovich | 4 | 8 |
| Lebedeva Aleksandra Vladimirovna | 4 | 16 |
| Kaledin Igor Vladislavovich | 4 | 6 |
| Grebenev Viktor Anatolievich | 4 | 8 |
| Kostyunina Irina Ivanonva | 4 | 6 |
| Pastushenko Antonina Vasilievna | 4 | 6 |
| Razina Zinaida Afanasyenva | 4 | 4 |
| Gusikhina Irina Aleksandrovna | 4 | 18 |
| Lilyonkov Valery Aleksandrovich | 4 | 16 |
| Mukhin Yury Stepanovich | 4 | 12 |
| Kostrykin Vladimir Stepanovich | 4 | 6 |
| Zakharov Aleksandr Ivanovich | 4 | 18 |

# Brief summary information on individual participants

|  |  |  |  |
| --- | --- | --- | --- |
|  | Total persons | Total days | Total grants ($USD) |
| Category I | 40 | 2220 | 58852.5 |
| Category II | 4 | 270 | 67500 |
| Category IV | 22 | 270 | 67500 |
| Total  | 66 | 2760 | 193852.5 |

# Project result statement

#### The medium scale experiment with characteristics: corium volume ~25 L, corium mass ~105 kg, corium temperature ~2500-3000C, heat fluxes towards walls and a bottom of a tank ~100-200 kw/m2, melt retention time 10-12 min was conducted.

# Foreign collaborators cooperation

With foreign collaborators we regularly interchange with technical information on MCCI experiments. We discuss the work progress and emerging scientific problems.

# Cooperation with subcontractors within CIS

#### Cooperation and project fulfillment organization

#### Work seminars, thematic meetings, organized by the participants of the Project

#### Signing of protocols (with brief description)

# Equipment summary.

|  |  |  |
| --- | --- | --- |
| Number according to Work Plan | Description of item  | Status  |
|  | **Equipment** |  |
| Table 2-1.1 | Notebook | SarPTI, b. 6, room 121 |
| Table 2-1.2 | Temperature measuring device | SarPTI, b. 6, room 121 |
|  |  |  |
|  | **Materials** |  |
| Tables 3-1.4,3-1.8, 3-1.9 | Concrete components, gas equipment | SarPTI, b. 6, room 121 |
| Tables 3-1.1, 3-1.3, 3-1.6 | Wire (rhenium, platinum etc.), metal-roll. | SarPTI, b. 6, room 121 |

# Conclusions, questions, proposals

Designed during the Project pyrotechnic technology of receiving and retention of corium can be used to carry out the large-scale experiment with the following characteristics: corium volume ~100-120 L, corium mass ~1000-1200 kg, corium temperature ~2500-3000C, heat fluxes towards walls and a bottom of a tank ~100-150 kw/m2, corium internal energy release time 1-2 hours.

