Mirror Cleaning

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ASTRI
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This project is part of a larger program in operations and maintenance and mirror cleaning. The purpose is to develop a cost-effective mirror cleaning systems for CST plants. It has been identified that automatically controlled high-pressure-jet washing is more time-effective than contact cleaning, and is quite suitable for CSP plants. The project is focused on the spray cleaning tests and dust characterisation.

Introduction

Dust collection and reflector weathering tests are being carried out at Collinsville Power station. The spray cleaning tests are to be performed at the UQ wind tunnel facility at Gatton which can measure 3-dimensional water droplet size and velocity profiles at various water pressures and flow rates. The larger project is a combination of theoretical modelling with testing for non-contact spray-cleaning systems. The tests will investigate cleaning effectiveness for various dust loads and surface types. Dust characterisation is conducted at the CARF facility at QUT.

Dust Monitoring and Characterisation

The deposition of dust on different reflector materials is being studied and the reflectance of each mirror before and after dust exposure is being measured. A test bench has been built and installed in Collinsville.

Five different types of mirrors have been prepared and placed on the bench. Ten samples with size of 400×400 mm (0.5mm thickness) are arranged in two rows and five columns. The first row of the mirrors are placed for dust accumulation for certain time period and they are then removed and used as the test samples for the spray cleaning. The second row of reflectors is cleaned every month and their reflectance is measured before and after each cleaning. A reflectance meter, 410-Solar, is used for measuring the reflectance of the mirrors. The reflectance measurement is carried out each time before and after the mirror wash. By doing this, the mirror surface reflectance degradation due to the dust deposition can be identified.
When washing each mirror, dust is collected by collecting the wash water. After removal of the water and drying, dust is characterised to determine dust composition and particle size.

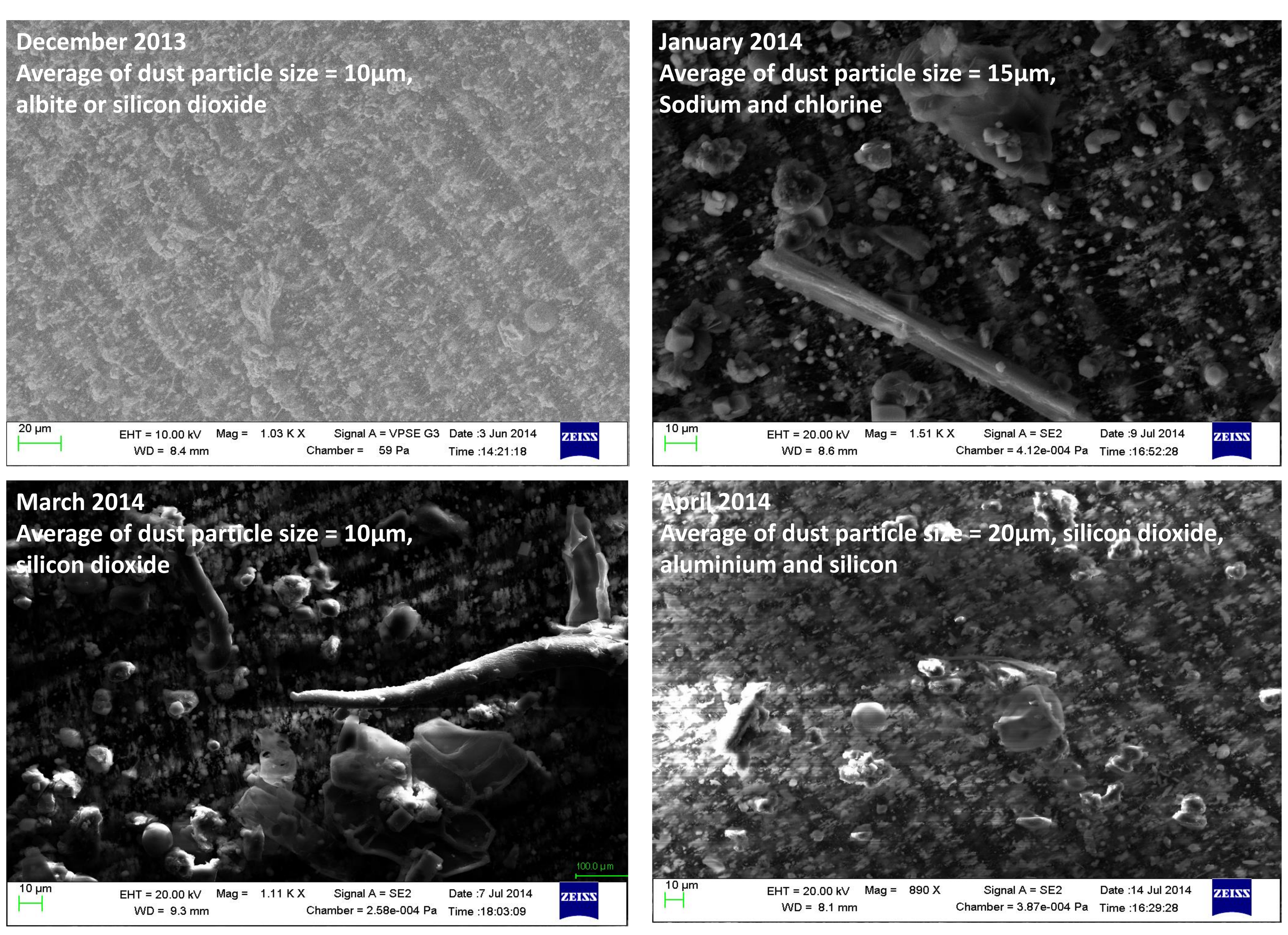

Figure 1: SEM results illustrate both physical and chemical properties of dust samples collected from Collinsville power station.

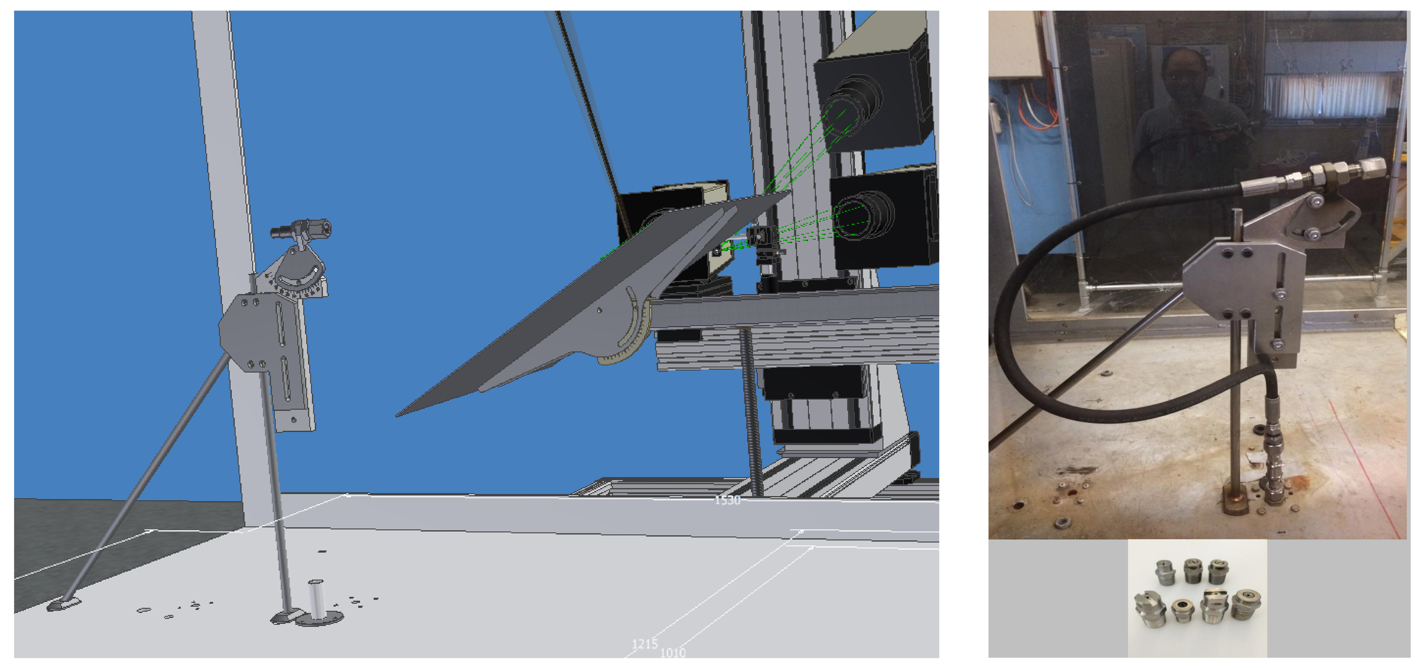

Figure 2: Set-up of spray nozzles and different nozzle types.

Spray Cleaning Tests [Calibri 44pt]

The spray cleaning tests are an experimental evaluation of the proposed high-pressure water cleaning (HPWC) technology for the removal of dust and other contaminations from the surface of high-quality solar reflectors. The tests are investigating water droplet velocity and size and the impact of these on the cleanliness of the reflective surfaces. UQ's Gatton wind tunnel was chosen as the testing facility for optimising solar mirror cleaning by high pressure jet washing. The experiments will test cleaning effectiveness on mirrors exposed to ambient dust at Collinsville, and also test cleaning effectiveness on reflectors dusted and fouled with Arizona road dust (a standard test).

- The test will investigate various parameters: the nozzle type, cleaning time (scanning rate), water pressure, angle of attack of the spray and distance to the reflector.
- Determination of the optimal high pressure water cleaning (HPWC) parameters and conditions.
- Determination of HPWC effectiveness over the surface of the mirror and for different reflectors before and after measuring the reflectivity.
- Determination and quantification of any potential damage to the surface of the reflectors as a result of HPWC; quantitative comparison of any such damage for different types of reflectors (e.g., with and without additional hydrophobic coating).
- Evaluation of the impact of coarse and fine particulate contamination of the mirror surface.
- Determination of the critical HPWC parameters acceptable for the efficient cleaning of the solar collectors without significant damage.
- Critical comparison of the proposed HPWC technology with the other existing cleaning methods currently adopted in the thermal solar power industry and practice.

Conclusions

It is expected that cleaning effectiveness will be a function of dust composition and reflector type. For Collinsville dust versus Arizona road dust; nozzle type, nozzle orientation, and nozzle distance to the reflector surfaces will need to be optimised. In addition, surface properties such as hydrophobicity and dust-surface interaction will influence cleaning effectiveness.

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