Summary

When designing a brand new terminal to handle biomass, particularly wood pellets, there are multiple fire hazards present one would have to deal with. The fire hazards in a biomass terminal are a big problem, considering the multiple fires in the recent past.

Ongoing research in the Marine and Transport Technology department of the Delft University of Technology is on the design of a biomass bulk terminal in which large amounts of wood pellets will be handled and stored. Therefore, the main research question is:

What are the fire hazards and how to prevent and extinguish fire during handling and storing in a wood pellets terminal?

To answer this question, first the properties of wood pellets will be studied. The properties of wood pellets have a big influence on the hazards of fire and on a fire itself.

The fire hazards due to the properties of the wood pellets are present due to two different ignition sources: external, localized sources of heat and due to self-heating. The external sources are in a biomass terminal: hot ambient temperature, mechanical forces, electric current or static electricity.

People are very much aware of the phenomenon of self-heating in a silo, but it is not well understood. It is clear that in a wood pellet silo there are certain reactions going on that heat up the bulk. This can lead to smoldering and eventually to self-ignition. Multiple researches have been done to understand and predict self-heating.

With self-heating it is known that somewhere in the silo is a hot spot. To detect a hot spot in the wood pellets in a silo or a hot particle in a handling process multiple detectors can be used, i.e. heat, spark, smoke or flame detectors. When detected an alarm can go off or an automated extinguishing system can turn on.

When a fire in a silo is propagated it can't be extinguished by conventional means. When a silo is extinguished by water, the wood pellets will suck up the water and there is a chance the silo will burst. When a fire in wood pellets in a silo is very hot, there is a chance that the water will never reach the fire front, due to evaporation. A silo fire can be extinghuished by means of inertion. Inertion will remove the hazardous presence of oxygen in the silo. Inertion can be performed with agents like nitrogen or carbon dioxide. To cool pellets further foam or gel can be used.

Examples of silo fires in the recent past show that a fire can be devastating. A silo building in Esbjerg, Denmark is completely demolished by a big fire. Since some years research is done to control a silo fire. The extinguishing process is better understood nowadays.

Conclusively, due to the properties of the wood pellets: they are combustible, emit flammable gases and fall apart and create dust, there exist multiple fire hazards which should be controlled. There should be a risk analysis made in which the fire hazards are stated.

With a fire hazard found, it should be controlled. This can be done with a detector. A fire in handling equipment can best be detected with a spark or a heat detector and can be extinguished downstream automatically.

In a silo, the fire hazard is self-heating. Wood pellets will self-heat for some time before reaching a thermal rundown and ignite. When a silo is heating up, the CO-concentration in the silo rises or the oxygen level depletes, this can be detected with a fire gas detector. When a heating reaction is detected, the hot spot should be found. One can do this with a thermal imager. With the hot spot found a plan can be made: empty the silo, shuffle the pellets around, cool the hot spot etc.

When a fire in a silo emerges, the silo should be sealed off; inert gases should be put in the silo, nitrogen from below and carbon dioxide from the top. A foam or gel should be used to extinguish the fire properly.