OIL SANDS TAILINGS TECHNOLOGY:
UNDERSTANDING THE IMPACT TO RECLAMATION

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ABSTRACT

Managing tailings is a critical component in the development of oil sands mines; the choice of tailings technology impacts reclamation schedules and outcomes. When tailings are released to a pond, a layer forms called Mature Fine Tailings (MFT) which is made up of fine clay particles suspended in water. The challenge is that MFT do not settle within a reasonable timeframe. As a result, Suncor has needed more and larger oil sands tailings ponds to store MFT over the years. In the 1990s, Suncor Energy pioneered consolidated tailings technology to accelerate the consolidation of MFT. Tailings Reduction Operations (TRO) is a new approach to tailings management. TRO is the process of mixing MFT with a polymer flocculent, then depositing it in thin layers and allowing it to dry. This new process has significant benefits such as: accelerating reclamation, reducing the need for more tailings ponds and reducing the existing inventory of MFT.

Suncor began reclamation of tailings in 1971 with varied success. The development of Consolidated Tailings technology required new reclamation techniques and resulted in significant research. Examples of existing tailings reclamation will be discussed. The impact of TRO on reclamation schedules and closure plans will also be discussed.

Key Words: Consolidated Tailings; Tailings Reduction Operations; MFT; mature fine tailings

INTRODUCTION

Commercial extraction of oil sands began in 1967 at Great Canadian Oil Sands (GCOS) in Fort McMurray, AB. Fort McMurray is located in the north-eastern boreal forest in Alberta. GCOS is now known as Suncor Energy. Suncor operates an open pit mine where bitumen is extracted from oil sand and refined into synthetic crude oil. After mining has progressed, Suncor reclaims the land to natural boreal forest.

OIL SANDS TAILINGS

Oil sand is composed of 80-85% mineral, 10-15% bitumen and 3-4% water by weight. The mineral component of the oil sand contains both sand and fines. Sand is defined as having a particle size greater than 44 microns and fines have particle sizes less than 44 microns.

Bitumen is separated from oil sand using the Clark Hot Water Extraction process. The remaining sand, fines and water combine to produce “tailings”. Tailings are an important component of oil sands operations and must be properly managed to minimize environmental impacts and operational cost.
OIL SANDS TAILINGS TECHNOLOGY

Many technologies have been researched in attempts to effectively manage oil sands tailings. Throughout 40 years of operation, Suncor Energy has used four types of tailings technology: Regular Tailings (RT), Densified Tailings (DT), Consolidated Tailings (CT) and Tailings Reduction Operations (TRO).

RT are simply the combination of sand, fines and water pumped to holding ponds called “tailings ponds.” No additional treatment is used for RT. DT are created when RT are cycloned. Through the process of cycloning, additional fines are separated from tailings. The overflow from the top of the cyclone consists of water and fines; the underflow material is called DT and consists of sand, water and residual fines. DT are primarily used as a construction material to construct sand dykes to enclose tailings ponds.

In tailings ponds, segregation occurs with the heaviest material, sand, settling to the bottom of the pond. The water will rise to the top of the pond and be recycled back to the extraction process. Within the pond, several layers will start to form. Thin fine tailings (TFT) will start to form almost immediately. TFT is a combination of fines and water less than 30% solids. TFT will consolidate and within approximately a three year period and will start to form mature fine tailings (MFT). Figure 1 shows the segregation of tailings within a tailings pond.

![Figure 1: Segregation of tailings within a tailings pond](image)

MFT is a mixture of fine clay particles and water, it is approximately 30% solids and has a consistency similar to yogurt. The challenge is that fine clay particles in MFT can take decades to consolidate sufficiently to be able to reclaim the material. As a result, Suncor Energy has needed more and larger tailings ponds over the years to store MFT. Currently, Suncor has a total of nine tailings ponds covering 31.8 square kilometers. Within these ponds, approximately 230 million cubic meters of MFT is stored. Tailings ponds at Suncor’s Oil sands mining operation cover approximately 30% of total disturbed land and will be significant features in the reclamation landscape.

A big challenge in oil sands tailings is treating MFT. MFT is not trafficable and therefore cannot be reclaimed as is. Over time, MFT will consolidate to a denser material, but this could take decades before being able to traffic on the material. Therefore, tailings technology has focused on how to accelerate consolidation of MFT.

Throughout the 1990’s Suncor pioneered a tailings technology known as Consolidated Tailings (CT). CT is produced by mixing tailings sand, gypsum and MFT to create a mixture that will consolidate more
quickly and release additional water. To make CT, MFT is dredged from the tailings ponds and mixed with densified tailings, then gypsum is added. The resulting CT is pumped to the tailings ponds and over time it will become denser, consolidate and water will be released. Suncor used CT technology for more than 10 years; however, CT has a number of challenges associated with the process.

First, production of CT is heavily tied to the extraction process. The required densified tailings come directly from the extraction process; therefore the extraction plant must be running in order to produce CT. This is important, because it means that during plant maintenance, CT production will be unavailable; CT can only be produced during operations, and no tailings treatment can occur after mine life using this method.

Second, a precise recipe of MFT, densified tailings and gypsum is required to make on-spec CT. Any deviations from that recipe will result in “off-spec CT.” Off-spec CT could produce a material that would not be trafficable and therefore cannot be reclaimed.

Third, CT must be deposited into a CT layer within the tailings pond. Failing to deposit CT into an existing CT layer means that the material will segregate in the pond and once again form MFT.

Because of these challenges, Suncor continued to research other tailings technologies. In 2003, Suncor began testing a technology known as MFT drying. In 2010, Suncor received regulatory approval to use MFT drying as a tailings technology of choice. MFT drying is known as Tailings Reduction Operations (TRO).

The TRO process begins exactly like CT. MFT is formed in the tailings ponds, and then dredged out of the ponds to use in the process. In TRO, a polymer flocculent is added to the MFT. The MFT/flocculent mixture is then deposited in thin layers with shallow slopes. The deposited layers are generally 10-15cm thick. Over a matter of weeks, the material dries resulting in a product that can be reclaimed in place or moved for final reclamation. Figure 2 illustrates the TRO process.
Suncor’s choice of tailings technology impacts reclamation planning. The first impact is the life cycle of tailings.

Both TRO and CT technology require the construction of a tailings pond to hold MFT. Mining the oil sand, constructing a tailings pond and forming MFT constitute the first stage in the life cycle of oil sands tailings. The choice of treating the mature fine tailings by using either CT or TRO results in significantly different time frames for the second stage.

Using CT technology, the CT pond may have to consolidate for up to 30 years until it has a trafficable surface that can be reclaimed. In contrast, using TRO technology, the MFT develops a trafficable surface within weeks. This is important because TRO allows more flexibility in the reclamation plan, and allows Suncor to choose the pace of reclamation, as opposed to requiring a 30-year wait until a significant portion of the landscape can be reclaimed.

TRO technology also provides flexibility in the choice of deposition area. CT must be deposited into constructed tailings ponds. However, TRO can be used on tailings sand beaches, overburden dumps or previously undisturbed areas. The depositional site for MFT is called a Designated Disposal Area (DDA); these can either be reclaimed as is, or re-used to dry an additional lift of MFT. This flexibility allows reclamation and tailings planning more control on the location and extent of areas to be disturbed by tailings.
RECLAIMING OIL SANDS TAILINGS

The choice of tailings technology also impacts the techniques used to reclaim tailings.

Suncor currently has 3 CT ponds and none have been reclaimed. However, a significant amount of research has been done to determine the best methods to reclaim CT ponds.

As noted above, with CT technology, the tailings ponds must be allowed to consolidate for a period of up to 30 years. During this consolidation period, water is released from the consolidated tailings. This causes the solid tailings to settle over time, which creates depressions or low-spots on the top of the tailings pond. It is difficult to predict the rate and amount of settlement, but this factor must be considered in the reclamation planning process.

It is anticipated that the water release and settlement will be used to create wetlands on the top of the tailings ponds. These wetlands will be an important component of the reclaimed landscape providing water treatment and surface water management. The released water from CT has a high salt content due to the gypsum added to the process. Therefore, it will be important to use native vegetation that is tolerant to salt in these wetlands areas.

In contrast, TRO technology creates a dry landscape. Suncor has been reclaiming tailings sand areas and overburden areas since 1971; and reclamation techniques used to reclaim dry landscapes are well established.

Dried MFT is a new material type and research is being done to determine the optimum reclamation techniques. MFT has a high clay component, and its value in providing moisture retention at surface for vegetation is being assessed. Research is also being conducted to determine the appropriate level of coversoil required on top of dried MFT to promote good vegetation growth.

CONCLUSION

Suncor is currently changing tailings technology from Consolidated Tailings to Tailings Reduction Operations. TRO is expected to manage tailings more efficiently than CT, and also has several benefits for reclamation.

TRO will reduce the need to build more tailings ponds, because, going forward, MFT can be consumed more quickly than they are generated. TRO can also be used to reduce Suncor’s MFT inventory, because TRO can operate independent of extraction plant operations. TRO also has several reclamation benefits including acceleration of reclamation compared to CT technology, enhanced flexibility in final tailings placement sites, and potential to use well known dry land reclamation techniques.