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RELIABILITY OF ALUMINA AND COKE CONVEYORS AT ADITYA ALUMINIUM, HINDALCO INDUSTRIES LIMITED, LAPANGA, ODISHA

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Abstract-*This paper presents an applied reliability study on acoustic testing of alumina and coke conveyors at Aditya Aluminium, Hindalco Industries Limited, Lapanga, and Odisha. Aditya Aluminium is an integrated aluminium smelter complex with tightly linked raw-material handling, smelting, power, and carbon-related operations, which makes conveyor reliability fundamental to uninterrupted production. Alumina and coke conveyors are critical because they transport essential raw materials for electrolytic reduction and anode-related process continuity. The attached conveyor design sheet, acoustic reports, and field photographs were used as the primary basis for this paper, together with public plant information and technical references on conveyor acoustics and fault detection.*

Keywords-Acoustic testing, conveyor reliability, alumina conveyor, coke conveyor, Fluke i910, ultrasonic inspection, belt conveyor, Aditya Aluminums, condition-based maintenance, smelter reliability.

1. INTRODUCTION

Aditya Aluminums at Lapanga is one of Hindalco's major aluminum operations and functions as a highly integrated industrial complex in which raw-material handling systems support core smelter performance. In such a plant, conveyors are not merely transporting equipment; they are process-enabling assets, whose failure can propagate into production loss, maintenance disruption, housekeeping deterioration, and increased risk exposure. For alumina and coke systems in particular, uninterrupted conveying is indispensable because these materials form the basis of smelter feed and carbon-process continuity.

The need for early detection of conveyor defects is therefore strong. Conventional inspection methods such as routine visual checks and localized vibration measurement remain valuable, but long conveyor routes containing thousands of rotating elements demand a faster screening approach. Acoustic testing using ultrasonic or high-frequency sound detection provides that capability by enabling rapid route-based scanning and defect localization before visible damage or catastrophic failure occurs.

2. PLANT DESCRIPTION AND PROCESS COMPLEXITY

Aditya Aluminium is an integrated smelter complex where several subsystems must operate in coordination, including raw-material receipt and handling, storage, conveying, process feed systems, power support, and smelting operations. The complexity of the plant lies in this interdependency: a disturbance in one enabling system can affect multiple downstream functions. This is especially true for bulk material conveying routes that transport production-critical raw materials over long distances through enclosed galleries and structural spans.

The conveyor photographs supplied for this paper show long enclosed gallery arrangements, extensive idler stations, structural steel frameworks, guarded access walkways, and utility/fire-water piping. These features illustrate both the engineering scale and the maintenance complexity of the conveyor system. They also demonstrate why route-based screening tools are valuable in practice, as the number of rotating elements is large and manual point-to-point assessment is time-intensive.

3. FIELD PHOTOGRAPHS

Figure 1: Enclosed conveyor gallery showing long route, idler arrangement, walkway, and service piping.

Figure 2: Conveyor gallery perspective highlighting scale, accessibility, and inspection path.

Figure 3: Central long-run view showing the distributed nature of conveyor rotating elements

Figure 4: Additional gallery view supporting route scale and maintainability discussion

4. CONVEYOR DESIGN AND SYSTEM IMPORTANCE

The attached design sheet for belt conveyor 831 BC-01 identifies a rated capacity of 1200 TPH, design capacity of 1380 TPH, horizontal length of 258.3 m, lift of 44.3 m, and maximum inclination of 11 degrees. These values confirm that the conveyor is a major process asset with significant throughput responsibility and nontrivial mechanical loading. Conveyors of this class typically contain numerous idlers, pulleys, supports, splices, and loading/discharge interfaces, all of which must perform reliably to avoid feeding interruptions.

In an aluminum smelter context, conveyor failure has consequences beyond mechanical downtime. Alumina is the primary feed for electrolytic reduction, and coke is critical to carbon and anode-related functions. Because of this, conveyor reliability directly supports plotline continuity, maintenance stability, housekeeping, and overall production assurance. The reliability objective is therefore not only to repair failures quickly, but to detect degradation early enough to prevent failure from occurring.

5. ACOUSTIC TESTING TECHNOLOGY

Acoustic testing is a high-value advanced condition-monitoring technique for long conveyor systems because it captures abnormal sound energy generated by defective rolling elements, friction, misalignment, and related mechanical distress. When combined with route-wise inspection practices, it enables large populations of rollers and rotating components to be screened more rapidly than traditional point-based methods. This is especially useful in enclosed galleries where access is repetitive and where defects must be localized before they escalate into belt damage or forced stoppage.

The present work refers to Fluke i910 technology in the context of industrial acoustic imaging and ultrasonic detection. Acoustic imagers of this type are used to identify high-frequency sound sources associated with friction and other abnormal conditions, allowing the maintenance team to pinpoint suspect locations along the conveyor route. The inspection reports also indicate practical use of digitally traceable acoustic survey methods, including MECQ feature capture information, which supports systematic auditing and defect tracking.

Advantages of Acoustic Technology

- **Early fault detection:** Identifies defects in bearings, rollers, and misalignment at an incipient stage before visible damage or vibration spikes occur.
- **Rapid inspection of large systems:** Enables fast, route-based scanning of thousands of conveyor components, drastically reducing inspection time.
- **Precise fault localization:** Acoustic imaging pinpoints exact defect locations, minimizing trial-and-error during maintenance.
- **Fire hazard prevention:** Detects abnormal friction and overheating, helping mitigate ignition risks in alumina and coke dust environments.
- **Improved maintenance prioritization:** Converts large datasets into targeted actionable defects, enabling focused and efficient maintenance planning.
- **Digital traceability:** Ensures structured data capture, auditability, and historical trend analysis for reliability decision-making.
- **Reduced downtime and secondary damage:** Early intervention prevents belt damage, breakdowns, and cascading failures.
- **Effective in inaccessible areas:** Highly useful for long, enclosed conveyor galleries where conventional inspection is difficult.
- **Complementary to vibration analysis:** Acts as a fast-screening tool, enhancing overall condition-based maintenance (CBM) strategy.
- **Supports cost optimization:** Minimizes unnecessary maintenance and aligns with cost-control frameworks while improving asset reliability.

6. ACOUSTIC TEST REPORTS

The referenced acoustic report for AHS Belt Conveyor BC-01 documents a structured acoustic inspection under Smelter Reliability CBM. The report shows target-point-based assessment and detected points, indicating that the alumina-handling system has already been subjected to organized route inspection. This evidence is important because it demonstrates field application of acoustic reliability methods on plant equipment rather than a purely theoretical discussion.
Together, these evidence shows that acoustic auditing can inspect large populations of rollers and isolate a smaller defect set for maintenance action, which is exactly the type of leverage needed in long conveyor systems.

Figure 1.1: Snapshot from the AHS BC-01 acoustic report showing Section -282 roller 01 with measured level 57 dB

Figure 1.2: Snapshot from the AHS BC-01 acoustic report showing Section 263 roller 1 with measured level 41 dB

Figure 1.3: Snapshot from the AHS BC-01 acoustic report showing Section 184 roller 1 with measured level 38 dB

Figure 1.4: Snapshot from the AHS BC-01 acoustic report showing Section 172 roller 1 with measured level 45 dB

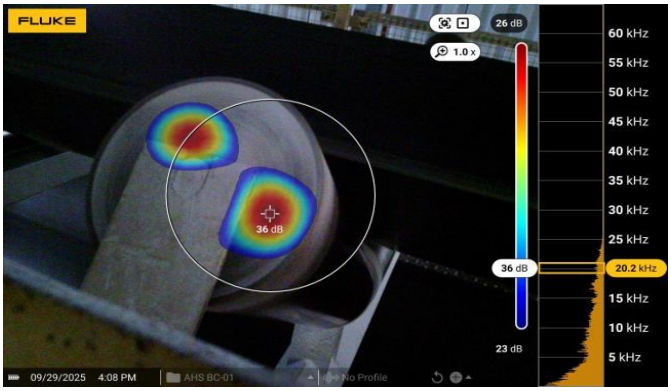

Figure 1.5: Snapshot from the AHS BC-01 acoustic report showing Section 170 roller 2 with measured level 36 dB.

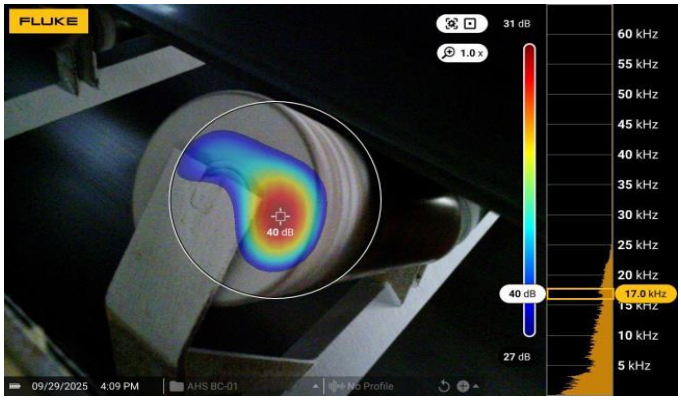

Figure 1.6: Snapshot from the AHS BC-01 acoustic report showing Section 125 roller 1 with measured level 40 dB

7. DB BASELINE DEVELOPMENT AND DEFECT CATEGORIZATION

A useful extension of acoustic conveyor testing is the development of a route-specific dB baseline so that detected points can be classified by severity instead of being reported only as isolated readings. For the visible AHS BC-01 report data, the measured sound-pressure values were analyzed to establish a practical operating baseline. The median of the visible readings is 41 dB, the lower quartile is 38.75 dB, the upper quartile is 42.75 dB, and the maximum observed value is 57 dB. These values indicate that most detected points are grouped in a relatively narrow band around the low-forties, while one location is clearly separated as a high-severity outlier.

For maintenance decision-making, the following categorization logic is proposed for this route: Normal at or below 39 dB, Watch from 40 to 44 dB, Alarm from 45 to 49 dB, and Critical at or above 50 dB. Using this approach, the 36 to 39 dB points may be treated as low concern or confirmation-check observations, the 40 to 44 dB group may be monitored and trended, the 45 dB points may be prioritized for planned intervention, and the 57 dB point should be treated as the highest-priority inspection location. This kind of banding makes the report more actionable because it converts measured sound levels into maintenance categories.

Category	dB Band	Suggested Maintenance Response
Normal	<= 39 dB	Acceptable / verify during routine inspection
Watch	40–44 dB	Monitor trend and inspect in planned round
Alarm	45–49 dB	Likely developing defect; plan correction
Critical	>= 50 dB	Immediate inspection / corrective action

This baseline framework can be strengthened further in future campaigns by collecting a larger number of healthy-route measurements under similar operating conditions and by correlating acoustic levels with physical inspection findings, roller replacement history, vibration readings, and operating load. Over time, route-specific baselines can become stable reliability standards for alumina and coke conveyors, enabling trend-based maintenance rather than one-time defect screening.

8. DISCUSSION

The attached photographs and reports together support a clear reliability conclusion: the conveyor routes under consideration are large, repetitive, and mechanically dense systems that benefit from rapid screening technologies. Acoustic testing fits this need well because it can be applied route-wise, improves defect localization, and supports prioritization of suspect rollers or locations before severe secondary damage occurs. In a plant handling alumina and coke for aluminium production, that early detection capability has strong operational value.

Acoustic testing should be treated as part of a broader condition-based maintenance framework. It complements vibration analysis, visual inspection, maintenance history, and shutdown planning. For a reliability function, the combination of acoustic and vibration evidence can significantly improve diagnostic confidence and improve the quality of maintenance decisions on conveyors.

9. RECOMMENDATIONS

It is recommended that route-wise acoustic testing be formalized for critical alumina and coke conveyors, with inspection frequency based on asset criticality and defect history. Results should be trended by conveyor section and correlated with roller replacement data, belt incidents, and vibration observations. Design information should be used to identify high-risk zones such as loading points, inclined sections, transitions, and discharge areas for focused monitoring. Where available, Fluke i910 or equivalent acoustic-imaging tools should be used to improve localization and speed of inspection in long conveyor galleries.

10. CONCLUSION

The alumina and coke conveyors at Aditya Aluminium are critical production-support systems whose reliability directly impacts plant continuity and operational stability. The design data, field observations, and acoustic audit reports collectively highlight the complexity of the conveyor network and underscore the practical effectiveness of acoustic inspection. Acoustic testing enables early identification of incipient defects in rollers and rotating components, facilitating timely maintenance prioritization and minimizing the risk of unplanned stoppages. In addition, early detection of abnormal friction and overheating through acoustic methods significantly contributes to mitigating potential fire hazards, particularly in dust-prone conveying environments handling alumina and coke. Overall, the integration of acoustic testing within the condition-based maintenance framework enhances system reliability, improves safety, and supports sustainable smelter operations.

11. ACKNOWLEDGEMENT

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REFERENCES

1. Hindalco Industries, Aditya Aluminium plant overview and operations.
2. Public technical references on aluminium smelter raw materials and process dependence on alumina and carbon inputs.
3. Technical references on conveyor noise, acoustics, and acoustic-based fault detection.
4. Conveyor design datasheet for belt conveyor 831 BC-01.
5. AHS Belt Conveyor BC-01 acoustic report.
6. Pipe conveyor roller acoustic audit report.
7. CHS pipe conveyor roller testing report.
8. Attached field photographs of conveyor gallery and idler arrangements.